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16. ABSTRACT

Southern California highways have provided the means of transportation which is a necessity in an area where the geography, lifestyle and city planning have all encouraged the growth of a complex highway system. However, this transportation system has also provided noxious and inconvenient by-products, such as air pollution from vehicle emissions and noise pollution from cars, buses, trucks, and motorcycles.

The public's concern for the pollution of the environment is becoming increasingly evident and their demands have been heard by governmental and public service agencies. Air and water pollution have received more attention than the third pollutant- noise; but noise can no longer be dismissed as inconsequential, in view of current studies which recognize noise as a public health hazard.

The California Division of Highways has responded to this problem of the unwanted effects of vehicle noise with a concerted effort to produce comprehensive studies of the noise environment surrounding California highways. The Materials and Research Department has developed a test method for measuring and evaluating noise at properties adjacent to highways. They have devised and refined a method for quantifying noise so they may answer a community's questions about the present noise level in the various neighborhoods and the predicted noise level after a new project has been constructed.

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Principal Investigator: Arnold M. Small

COMMUNITY RESPONSE TO FREEWAY NOISE IN LOS ANGELES COUNTY

(A Social Survey)

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Business and Transportation Agency
Department of Public Works
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NOISE STUDY

GEOGRAPHICAL COVERAGE

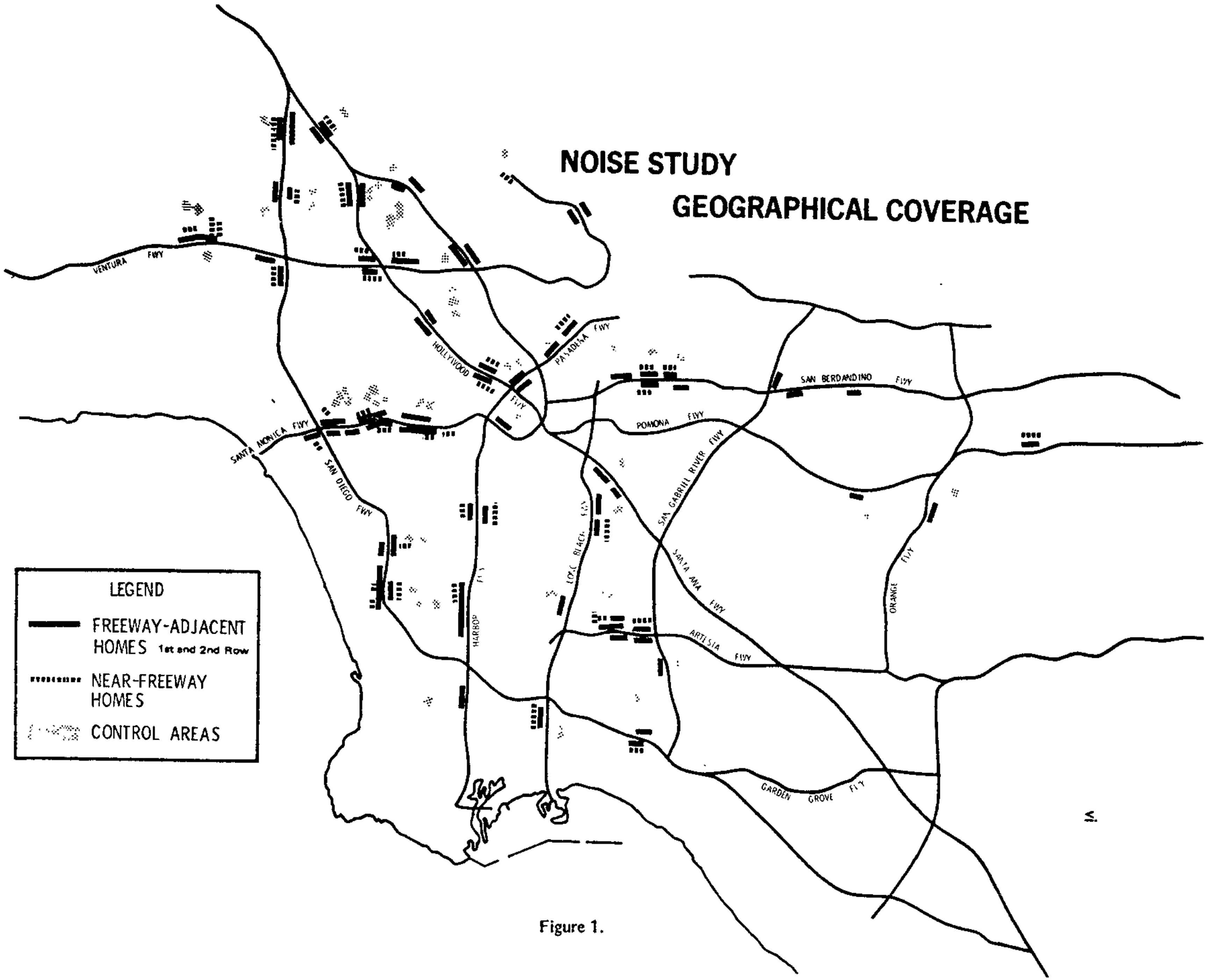


Figure 1.

SUMMARY OF FINDINGS

1. Noise is the most annoying feature of the freeways as expressed by a clear majority of residents living near them (74 percent of approximately 700 who were interviewed). Noise levels at the residences ranged from an L_{10} of 54 dB(A) to 87 dB(A) (with an average L_{10} of 70.3 dB(A)); and an L_{50} of 49 dB(A) to 82 dB(A) (with an average of 65.0 dB(A)).

2. Freeway noise interferes with and disrupts the daily lives of the surveyed residents:

   Falling asleep and/or remaining asleep 40%
   Television viewing 41%
   Relaxation 30%
   Outdoor recreation 53%
   Conversation 50%

3. Freeway noise is regarded as the major cause of dissatisfaction with a neighborhood (50 percent). It is the one feature residents want to change more than any other (42 percent). It is also the main reason residents want to move out of their neighborhoods (25 percent).

4. Residents give a negative reaction to freeway noise even if it is not then interfering with their activities.

5. Black people interviewed did not say they were disturbed by freeway noise even if they lived in the highest noise levels measured.

6. Freeway noise interferes with the daily life of those who live near freeways (median noise levels below 66 dB(A)), although these same people will not mention that they are disturbed by the noise.

In view of these research findings, the researchers conclude that freeway noise of the magnitude studied herein is a serious deterrent to the quality of life for people living in homes adjacent to freeways.

PROJECT OVERVIEW

Objectives

The California Department of Transportation has devised a method of measuring freeway noise, but the records of the measurements are cumbersome to evaluate and the final result is a decibel reading which lacks information about the quality of life at various noise levels. The University of Southern California developed a field noise measurement procedure which is easier and quicker to evaluate. With this procedure it became possible to conduct an extensive social survey which identified and, evaluated community response to freeway noise, and determined the relation of this response to the noise exposure as well as to psychosocial and physical characteristics of the community.

Research Design

Noise exposure was determined by one representative noise sample for each residence surveyed. Precautions were taken to restrict noise measurements to times of day which represented average prevailing noise conditions, to take measurements only when the non-freeway background noise was negligible, and to select field operators with at least graduate level backgrounds in the physical sciences.

Community response was measured by means of personal interviews of people living in homes near freeways, and for control purposes, of people living in similar neighborhoods farther away from freeways. The final questionnaire was the result of extensive pilot work. Precautions were taken to avoid unnaturally high levels of community response which occur when interviewers direct one's attention to a subject; to provide special treatment for lower socioeconomic classes who are known to be more reluctant to voice criticism; to provide a standard frame of reference for people who rated freeway noise and who would otherwise had disagreed on the upper limit for acceptance of a negative stimulus; and to select interviewers who have had experience in or graduate level backgrounds in counseling and psychology.

Survey Sample

We surveyed a random sample of about five percent of all people who live in homes directly adjacent to the freeways (in the first and second rows and within 500 feet of the freeway). This sample was not significantly different from the average Los Angeles resident on the demographic characteristics of age and race, but the average income of the sample was lower than the average income for all county residents. The average median noise level for the homes whose front faces the freeway (*i.e.*, the second row of homes) was 67 dB(A); whose rear faces the freeay (*i.e.*, the first row of homes) was 64 dB(A); and whose side faces the freeway was also 64 dB(A).

We also surveyed homes near freeways (from the third row to within one block of the freeway) with average median noise levels of 60 dB(A).

Evaluation of Noise Measures

A number of different noise measures exist to date, but none of th m are truly superior to the others. Rather than arbitrarily selecting one of these, it was decided to evaluate a variety of them with the objective of determining the best predictors of community response. All noise measures correlated highly with each other except for the Traffic Noise Index. A statistic based upon the median noise level and noise level fluctuations, the Noise Pollution Level, was the best predictor of spontaneously mentioned reactions against freeway noise. The median noise level (L_{50}) was found to be the best predictor of those community responses which were elicited by the more conventional means of directly questioning people.

As a consequence, many final results of this study are presented as a function of the median noise level, L_{50}. Results of other studies have recently been given as a function of the noise level, L_{10}; as a matter of fact, the Federal Highway Administration has even adopted the L_{10} as their standard noise level. Since both the L_{50} and the L_{10} were carried through this entire study, it was found that, on the average, the relationship between the L_{50} and L_{10} for the noise samples of this study can be approximated by $L_{10} \approx L_{50} + 5$ dB(A).

Validity of the Measures of Community Response

The measure of community response used in this study was tested to see if values were caused by any other factor than freeway noise. The measures do not appear to be caused by an personal characteristic such as age, race, income, or years of freeway exposure; nor by any physical characteristics of the home; nor by the involuntary coexistence which occurs when freeways are built in one's neighborhood after residence is established; which implies that the measures used in this study are valid indicators of community response to freeway noise.

Community Response and Noise Exposure

Although the most salient feature of the freeways for respondents in nonfreeway homes was the crowded conditions, *the noise from freeways was considered, by a clear majority opinion, to be the most salient feature for people in freeway proximal areas.* (See Figure 6.)

Community response to freeway noise increases with increasingly louder noise levels. *People who live in a noise environment with median noise level below 66 dB(A), report that their activities are interrupted by freeway noise, but only in noise levels above 66 dB(A) do their expressions of a negative, subjective reaction exceed their report of activity interruption.* (See Figure 7.) It follows that the lives of people who live near freeways are affected by the freeway noise, although these same people will not specifically mention that they are disturbed by the noise.

Certain specific reactions among people living near freeway noise become *increasingly more frequent* as the median noise level increases. Freeway noise is mentioned as the major cause of *dissatisfaction with the neighborhood* in which one lives, as *the feature that residents want to change* more than any other neighborhood feature and as the *major reason for wanting to move from the neighborhood.* (See Figures 7 and 8.) Complaints that freeway noise *interferes with conversations and interrupts daily activities* also increase as the noise level increases. (See Figures 7 and 9.)

The following consequences of freeway noise are reported with increasing numbers of complaints as the noise level increases, and then the *complaints level off* when 50 percent of the residents living near freeways report the complaint: difficulties of falling asleep and/or staying asleep at night; interference with television viewing; disturbance of relaxation; and inability to use their outdoor property for recreation. (See Figure 9).

Location of those People with Greatest Community Response

66 dB(A) has been mentioned as a level at which the type of community response changes to some extent. However, one should bear in mind that there are large numbers of people living in environments with median noise level less than 66 dB(A). In terms of all people who live near freeways, the greatest proportion of people with above-average levels of community response dwell in median noise levels between 58 and 62 dB(A), and the majority (52 percent) of people in that noise level live in the first row of homes which are directly adjacent to the freeway. (See Table 14.)

The Importance of Factors Other Than Noise

An individual's community response is likely to be influenced by factors other than the noise level to which one is exposed. A number of these factors was tested in combination for their multiple and their indirect influence. (The latter test also provided a predictive equation for community responses.) Different types of community responses were found to be influenced by different factors, and community responses which are spontaneously mentioned have different predictors than community responses which are "elicited" from a respondent. (See Table 17.)

The test of individual, direct influences revealed that *black people are not likely to say they have a subjective reaction to the freeway noise* even if they live in the highest noise levels; and that individuals who admit to being affected or disturbed in various ways by freeway noise are also likely to admit to a fear of freeway accidents occurring on their property, regardless of the noise level to which they are exposed.

The test of the collective influence of several variables in combination revealed the following: Community responses which are elicited from respondents (*i.e.*, statements to which one will agree once the subject is brought to one's attention) can be predicted from a knowledge of four variables. The first variable is a fear of freeway accidents occurring on one's own property. A second variable is annoyance with other features in one's neighborhood (other than freeway noise). The other variables include a belief that living near freeways is not an advantage, and a consciousness or alertness to the freeway noise.

A subjective reaction to freeway noise independent of any interference with daily activities is *mainly predicted by three variables.* The subjective response to freeway noise is greatest when the resident is conscious of or alert to the freeway noise; if he does not believe that living near freeways is an advantage, and if he is caucasian. (See Table 18.)

A Non-Freeway Control Group

A subsample of homes near freeways was matched with homes in neighborhoods which were similar but distant from the freeway. The control group had a record of fewer complaints to the authorities about problems in their neighborhood, less dissatisfaction generally, and fewer behavioral disturbances particularly in falling asleep at night. This control group did not differ significantly from the freeway residents in their general attitude toward freeways. However, the control group was more convinced than the freeway residents of the highway planners' consideration for the average citizen.

INTRODUCTION

Southern California highways have provided the means of transportation which is a necessity in an area where the geography, lifestyle and city planning have all encouraged the growth of a complex highway system. However, this transporation system has also provided noxious and inconvenient by-products, such as air pollution from vehicle emissions and noise pollution from cars, buses, trucks, and motorcycles.

The public's concern for the pollution of the environment is becoming increasingly evident and their demands have been heard by governmental and public service agencies. Air and water pollution have received more attention than the third pollutant—noise; but noise can no longer be dismissed as inconsequential, in view of current studies which recognize noise as a public health hazard.

The California Division of Highways has responded to this problem of the unwanted effects of vehicle noise with a concerted effort to produce comprehensive studies of the noise environment surrounding California highways. The Materials and Research Department has developed a test method for measuring and evaluating noise at properties adjacent to highways. They have devised and refined a method for quantifying noise so they may answer a community's questions about the present noise level in the various neighborhoods and the predicted noise level after a new project has been constructed.

The information which is obtained from the Division of Highway's test method consists of a decibel reading, but its relation to the quality of life has not been assessed yet in sufficient depth. The California Division of Highways has reviewed the current literature in an effort to identify acceptable limits of noise exposure (1, 28). The results of the studies are not in complete agreement, and the desired maximum noise exposure has been "loosely" defined as 70 dB(A). There is obviously a need for more information in order to establish limits of noise exposure for the inhabitants of dwellings near highways.

STUDY OBJECTIVES

Most of the results obtained to date from studies of community response to freeway noise are rather inconclusive because of very difficult basic problems which are intrinsic to studies of this type. First, it is very difficult to determine community reaction because a reaction against noise is constituted not only of the overt community actions but also of the feelings and attitudes in a community which are not overtly expressed and thus not directly observable. Secondly, it is a very tedious task to define a quantitative measure of community reaction which incorporates all relevant factors. Thirdly, the selection of a suitable noise measure as a predictor of community reaction is a very controversial issue to date. Fourthly, the noise exposure in a neighborhood depends upon a multitude of factors, such as distance from the freeway, traffic volume and speed, traffic composition, freeway grade, acoustic shielding by barriers, orientation of houses relative to the freeway, sound insulation properties of houses, open or closed windows and doors; but the quantitative evaluation of these relationships is complex and usually far beyond the means of a study. These four problem areas are not an exhaustive account of all possible problems encountered in the assessment of community responses to freeway noise.

Community complaints about any problems have traditionally been the result of a complex network of variables, such as season of the year or the election of a new public official. A change in any one of these complex factors could produce an increase in public complaints about freeway noise without a corresponding increase in the actual noise levels. Thus the amount of community response and the potential for complaints is not directly related to the frequency or volume of complaints registered against freeway noise.

It has been suggested (18) that there are several alternatives for studying the community's response to noise. Observation by a trained observer or participant is a method which, although valuable for the formation of hypotheses, requires additional testing for confirmation of these hypotheses.

Another method of value to the scientist is the laboratory experiment. The correspondence between laboratory studies and field studies is not as strong as one would prefer in order to make definitive statements about a community's true level of response. Among the many differences between real and simulated noise exposures studies which might account for the low level of correspondence are: (1) the inability to study sustained cumulative effects of noise exposure and (2) the absence of the mental attitude to home and privacy which have not as yet been duplicated or systematically varied in an experimental fashion.

A third method, a social survey, is conducted in the natural environment and is able to overcome the limitations of laboratory studies at the same time that it relinquishes a certain amount of control over the myriad psychosocial, cultural, political and historical factors which impinge on an individual at any moment. Borksy (3) suggests that an optimization of laboratory and field studies could be achieved by selecting certain participants of a social survey to participate at a later date in laboratory studies.

A comprehensive social survey is the first link in this chain of effects and is the subject of this report. In order to minimize the impact of the discussed problem areas within the constraints of time and resources which were available for this study, the study described in this report was designed to focus on the following areas: (1) the identification of individual and community responses; (2) development and implementation of a method for obtaining noise measurements representative of each surveyed home, (3) determination of the relation of these responses to the noise exposure and to psychosocial and physical variables, (4) evaluation of a variety of noise measures as predictors of community response to freeway noise, (5) development of quantitative predictors of individual response to freeway noise, and (6) comparison of neighborhood disturbances in freeway and nonfreeway areas.

CHAPTER ONE: NOISE MEASUREMENT

The Selection of Candidate Noise Measures

A multitude of noise measures has been proposed in the literature as predictors of community reactions to traffic noise. All of these have specific advantages, but also disadvantages. With the present state of the art, none of these measures can be selected as truly superior to the others. Rather than arbitrarily picking one of these for this study, it was decided to pick a variety of the most promising ones as candidate noise measures for this study. All the selected candidate measures were carried along all the way through the entire study with the objective of determining which of them correlated best with community reaction. The candidate noise measures selected for this study are described below.

A-Weighted Sound Pressure Level

The A-weighted sound pressure level is the most commonly used single-number scale for quantifying approximately the subjective noisiness of sounds, particularly those from vehicles other than aircraft. It is also readily measured with the use of a standard sound level meter employing the A-weighting network.

This measure has often proven to correlate well with human responses to noise. Hillquist (12), for example, conducted a study in which jurors were asked to rate their personal preferences for recorded noises from moving trucks. A study of the correlation of these ratings with a variety of noise measures obtained from the same noise recordings was then performed. This study revealed that the dB(A) measure was among the measures with the highest correlation coefficient. Galloway (9) conducted a statistical experiment correlating subjective ratings of motor vehicle noise with a variety of noise measures. In this study, it was also found that dB(A) is among the noise measures with the highest correlation coefficients.

It was concluded that there is enough evidence that the A-weighted sound pressure level is among the best single-number noise measures which correlate highly with human responses to noise. Another point to consider is the vehicle laws of the State of California which use the A-weighted sound level. Therefore, it was chosen as a candidate noise measure for this study. It has also been chosen as the basis from which all other candidate noise measures selected for this study are derived.

Statistical Noise Measures

The A-weighted sound pressure levels obtained with a sound level meter represent average values over certain time periods. There is some evidence that besides overall noise levels, short time fluctuations of the noise may also be of importance in connection with community reactions to noise. It was therefore decided to adopt a variety of candidate noise measures which incorporate information about short-time fluctuations of the noise level. Statistical noise measures can be easily computed if the probability density of the noise levels or the cumulative distribution of noise levels is known. The collection of statistical noise data yielding probability density and cumulative distribution of noise levels was therefore made a requirement for this study.

Since A-weighted sound pressure level has proven to be generally superior to sound pressure levels weighted otherwise, all the statistical noise measures outlined in the following were based upon time fluctuations of the A-weighted sound pressure level.

Simple Statistical Noise Measures

Given measurements of statistical noise level distributions, the mean level, the variance about the mean level, and levels such as the L_{10}, L_{50} and L_{90} can be easily obtained for the A-weighted noise levels. Here, L_n is the noise level which is exceeded n percent of the time; for example, L_{10} is the noise level which is exceeded 10 percent of the time. The L_{50} is the median noise level. The L_{90} can be considered as some kind of "background" level and L_{10} is some kind of an average "peak" level.

All of the above mentioned parameters were retained as candidate noise measures for this study.

Aggregate Statistical Noise Measures

A multitude of aggregate noise measures has been proposed in the literature. Of these measures the Traffic Noise Index, TNI, and the Noise Pollution Level, NPL, were chosen for closer investigation.

The Traffic Noise Index was suggested in 1968 by Griffith and Langdon (10) as a measure which applies specifically to traffic noise. This measure is defined as

$$\mathrm{TNI} = 4\,(L_{10} - L_{90}) + L_{90} - 30 \qquad (1)$$

It is an aggregate measure including L_{90} as some measure of the background noise and a strongly weighted term based upon the noise level variation, $L_{10} - L_{90}$; the last term in the equation (1) is simply introduced to yield more convenient numbers for the TNI.

At present, the viewpoints of scientists about the usefulness of the TNI differ widely. One study (10), for example, concluded that the TNI correlated highly with average community reaction to traffic noise; whereas another study (9), for example, found a very low correlation between the TNI and community reaction.

The Noise Pollution Level, NPL, was proposed in 1969 by Robinson (25) as a noise measure which applies to traffic noise among a variety of other noise sources. It can be defined by the equation

$$\mathrm{NPL} = L_{50} + \frac{1}{60}\,(L_{10} - L_{90})^2 + (L_{10} - L_{90}). \qquad (2)$$

It is evident that the NPL represents an aggregate measure incorporating the median noise level and two terms based upon the noise level variations, $L_{10} - L_{90}$. Correlating the NPL with the community reaction data of reference 10 yielded a correlation coefficient only slightly lower than the one found for the TNI.

The experimental results mentioned above for the TNI and the NPL seem to indicate that both measures warrant some promise as predictors of community reactions to traffic noise. Since both these measures can be directly derived from A-weighted statistical noise data, they were included in this study as candidate noise measures.

Test Method No. Calif. 701-A(1) defines procedures for measuring noise levels in areas adjacent to freeways. These procedures were developed at a time when sound level meters and graphic level recorders were the commonly available instruments. The typical output obtained with such instruments is a time history of strongly fluctuating noise levels. The procedures focus on the noise level peaks in the output and prescribe the computation of the peak level range and the near peak level. Results obtained with a sound level meter are often very dependent on the definition of a "peak" and may therefore vary from one research team to another. Results obtained with a graphic level recorder are objective, but the evaluation of the paper chart records is quite cumbersome.

In the past, many field measurements have been made using these procedures. With the advent of new instruments, records of the entire statistical distribution of noise levels can now be measured and thus more consistent noise measures can be derived. To correlate results obtained in this study with results obtained by the previous methods, it is desirable to include results obtained by the previous methods as candidate noise measures in this study. Unfortunately, statistical noise distributions do not enable the application of the Test Method No. Calif. 701-A.

In an attempt to simulate results from the above test method, it was decided to derive two additional candidate noise measures using only the high noise portion of the noise level distribution. These two noise measures were defined as:

DIL = the mean of only the high noise portion of the noise level distribution obtained by deleting all noise level bands below the one which contains the L_{50}.

DEL = the same as DIL with the exception that the noise level band which contains the L_{50} is also deleted.

Since these two candidate noise measures are derived from the peak noise levels similar to the California test method, they are believed to correlate with results obtained by that method.

The Noise Data Collection System

The Need for Field Measurements

Within a community adjacent to a freeway, there are usually substantial differences in the noise characteristics from point to point, depending upon distance from the freeway, obstructions in the noise propagation path, relative elevation with respect to the freeway, etc.

In principle, if the appropriate statistical properties of noise sources and propagation paths were given, it would be possible to compute the resulting noise characteristics at every point in the community under study. However, such a computation is typically very complex and also, adequate data on the noise sources and propagation paths are often not available. Therefore, it is more practical to determine community noise characteristics from direct field measurements at the various points of interest in the community.

Instrument Selection

A hand-held sound level meter is very useful for exploratory field surveys. However, when noise characteristics have to be measured and recorded accurately as a function of time, the sound level meter is not a very suitable instrument. The reason is that it does not record the readings. For the purpose of this study, an instrument was needed which recorded noise levels automatically.

In many studies, a graphic level recorder is used which yields a time trace of instantaneous noise levels on a paper chart. In principle, this instrument could yield statistical noise level distributions. However, the evaluations of the paper chart records for this purpose requires very cumbersome procedures.

For this study, an instrument was selected which overcomes the disadvantages of the graphic level recorder and, at the same time, is rather reasonable in cost. This instrument is the Environmental Noise Classifier, Bruel & Kjaer Model 166/SJ45. It was made the central instrument in the noise measurement program of this study.

Instrument Characteristics

1. **Environmental Noise Classifier**

The Environmental Noise Classifier, B & K 166/SJ45, is a noise analyzer which determines the average sound pressure level in consecutive 0.01-minute time intervals. The short-time average values thus obtained are classified into sound pressure level bands. There are 12 such bands which are alternately 2 and 3 dB wide, with the top band having no upper limit. The base level (lower level of the lowest band) can be set at 45 dB and at values between 60 dB and 100 dB in 5 dB increments.

A 4-digit mechanical counter is assigned to each of the 12 bands. A thirteenth counter, a master counter, shows the total time. In each 0.01-minute sampling period, the noise level is measured by the instrument and a pulse is delivered to the appropriate counter. The counters update their counts every time they accumulate 10 such pulses.

If a 0.01-minute average value falls below the lowest band, it will not be registered. The number of such counts not being registered can be computed as the difference between the total time meter reading, which counts the total number of 0.1-minute time intervals, and the sum of the 12 individual band readings.

The Environmental Noise Classifier is a self-contained instrument with a 1-inch piezoelectric microphone as standard equipment. With its ceramic microphone, the instrument meets ANSI Type 2 specifications (32). However, it has a special input through which it can be driven by other instruments, bypassing its standard microphone. In this study, it was driven by the sound level meter which meets the ANSI Type 1 specifications. In this combination, the Environmental Noise Classifier meets the ANSI Type 1 specifications.

The instrument is equipped with A, B, C and linear frequency weighting networks, with the linear frequency response being 20 Hz to 20 kHz.

2. **Power Supply**

The Environmental Noise Classifier is designed to be powered from a 115-volt, 60 Hz power source. For field operations, the voltage of a 12-volt Gould car battery was inverted with a dc to ac inverter, Lafayette Model PV-100.

3. Sound Level Meter

The Sound Level Meter, Bruel & Kjaer Model 2209, was used for exploratory field surveys and as a precision signal indicator. This is a compact, battery-operated instrument for precision sound and vibration measurements. It is equipped with A, B, C, D and linear frequency weighting networks, with the linear frequency response extending from 2 Hz to 70 kHz. Remote mounting of the microphone is possible via the use of a microphone extension cable.

This instrument complies with IEC R 179 requirements for precision and sound level meters and the proposed IEC recommendation for an impulse sound level meter. It meets the ANSI Type 2 specifications (32).

This instrument provides a low impedance ac output voltage, proportional to its meter deflection, for driving other instruments like the B & K Environmental Noise Classifier or a magnetic tape recorder.

The sound level meter was calibrated with a Piston Calibrator, Bruel and Kjaer Model 4220.

4. Magnetic Tape Recorder

The tape recorder used in this study was a Nagra Model SJS. This is a portable 1/4-inch scientific recorder, operated by batteries. This instrument can record and reproduce two separate amplitude modulated sound tracks simultaneously in the 25 Hz to 35 kHz frequency range. The input to this instrument can be driven from the ac output of the B & K 2209 sound level meter as was done in this study.

The tape recorder was used for noise recordings in the field whenever two field operators were sent out at the same time. In this case, one of the operators used the Environmental Noise Classifier while the other recorded the noise on magnetic tape. Later, in the laboratory, the tape records were played back into the Environmental Noise Classifier.

Instrument Setup for Noise Measurements

All final noise measures used in this study were derived from the output of the Environmental Noise Classifier. All the other instruments described above were used in an auxiliary capacity to the Environmental Noise Classifier.

As described above, noise measurements in the field were taken in two different ways. The standard procedure was to use the Environmental Noise Classifier directly in the field with the instrument setup shown in Figure 2. Tape recordings in the field were made if two field operators were scheduled for the same time or if the Environmental Noise Classifier was malfunctioning. Whenever tape recordings were made, they were taken to the laboratory where they were played back into the Environmental Noise Classifier when it was not being used in the field.

The instrument setup shown in Figure 2 was chosen for two basic reasons. One reason is that the chosen setup meets the ANSI Type 1 specifications (32), despite the fact that the Environmental Noise Classifier 166/SJ45 by itself meets only ANSI Type 2 specifications (32). The second reason is that the specific setup shown in Figure 2 extends the dynamic range of the Sound Level Meter 2209 as a signal conditioner.

The advantage of this second feature for this study becomes obvious when the operational features of the Environmental Noise Classifier are analyzed in relation to the specific needs of this study. As explained in more detail below (Appendix A), it is desirable to adjust the base level setting, X, of the 166/SJ45 so that the maximum of the noise level distribution shows in the middle windows of the 166/SJ45. The maxima of the noise level distributions encountered in this study often fell into the range between 60 dB(A) and 75 dB(A). Taking the 166/SJ45 by itself, the two lowest base levels that can be set are either 45 dB(A) or 60 dB(A) respectively. This puts the middle windows either at about 60 dB(A) or at about 75 dB(A) respectively, *i.e.*, the instrument is used in a range where it cannot be adjusted in finer steps. At other times the lowest noise levels encountered in the field fell below the lowest possible base level of 45 dB(A).

This demonstrates the need for amplification of the input signal to the 166/SJ45 for two reasons. First, proper signal amplification can assure that even the lowest noise levels encountered in the field are brought into the dynamic range of the 166/SJ45. Secondly, by

NOISE MEASUREMENT SET UP

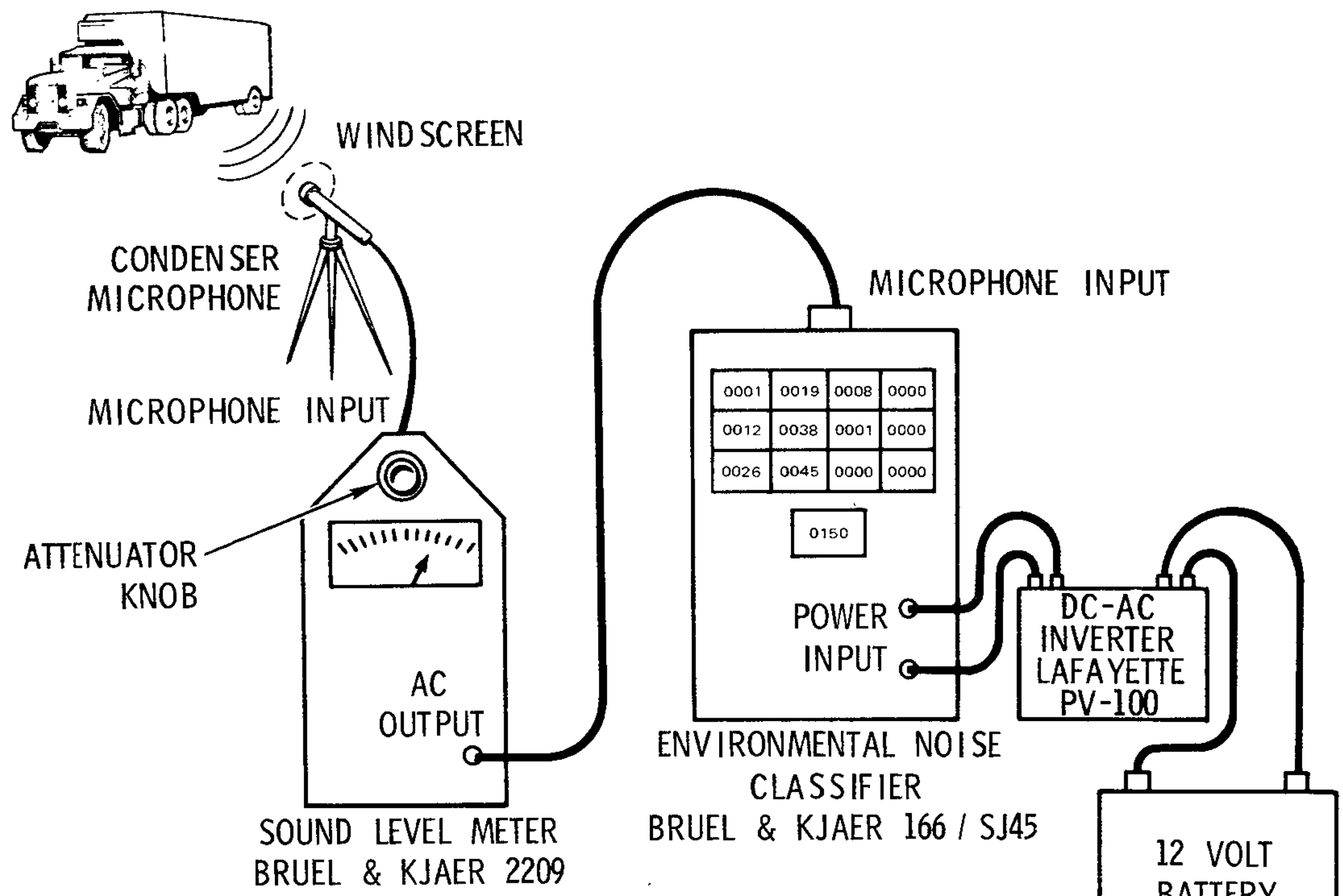


Figure 2.

selected suitable signal amplification it becomes possible to use the 166/SJ45 in its 60 dB–100 dB base level range where fine adjustments of the base level can be made in 5 dB increments.

The need outlined above was met by the use of the Sound Level Meter 2209 as a precision signal indicator. This instrument yielded suitable signal amplification in all cases due to its capability of adjustable signal amplification in steps of 10 dB over a wide dynamic range. A more detailed description of the interfacing characteristics of the 2209 and the 166/SJ45 instruments is given in Appendix A.

Noise Data Collection

Freeway Noise and Ambient Noise

In this study of the effects of freeway noise on residents in residential neighborhoods, freeway noise is singled out from the multitude of noise sources contributing to the noise environment of the neighborhood. For the purpose of this study, noise from all sources other than the freeway is considered "ambient noise." In this study, ambient noise is therefore made up of a multitude of noises from sources such as surface street traffic, aircraft, lawnmowers, barking dogs, etc. In the residential neighborhoods selected for this study, noise sources such as heavy construction equipment, industrial plants, etc., are typically not present.

The power of the freeway noise depends upon parameters such as traffic flow rate, average vehicle speed, and the percentage of trucks, all of which are a function of time of day. For example, the average noise level increases by 3 dB for doubling the traffic flow rate, and by 6 dB for doubling the average vehicle speed.

For locations with direct line of sight to the freeway traffic, the average freeway noise level decreases somewhere between 3 dB to 6 dB for every doubling of distance from the freeway centerline (see Reference 9 for example). At distances of the order of 500 to 1000 feet from the freeway, the average noise level approaches the ambient noise level in a typical neighborhood.

In order to study the effects of freeway noise upon residents, residences were therefore chosen which were typically not more than 500 feet from the freeway.

Spot Selection for Noise Measurements

Ideally, for each residence surveyed, measurements of noise characteristics should be performed at a variety of strategically located points so that noise samples are acquired for all important activity spots outside the house, such as the front door and the backyard, as well as inside the house, such as living room, den, and bedrooms. Results obtained will also depend upon the orientation of the house relative to the freeway. Furthermore, the results of inside measurements will depend critically on whether windows and doors are open or closed, so that ideal inside measurements would have to be replicated to include these various possibilities.

Unfortunately, the scope of such an ideal measurement program becomes completely impractical considering the large sample sizes needed for sufficient statistical significance of the results to be developed in this study (see Chapter Two for a discussion of sample size). Therefore, the ideal noise measurement program had to be drastically curtailed to make it realistic within the time and funding constraints which prevailed for this study.

It was decided to perform the study with one representative noise sample for each residence surveyed. With this policy, it had to be decided whether to sample noise inside or outside a residence. It is likely that both inside and outside levels play a role in community reactions. Inside noise is a complex function of outside noise depending on factors such as house orientation relative to the freeway, sound insultation properties of the house, opened or closed windows and doors, windows facing the freeway or not. The outside noise levels, on the other hand, do not depend on such variables, which means that they are not affected by specific properties of the dwellings and living habits of the residents. Outside noise levels are also much easier to measure than inside noise levels. Therefore, it was decided to obtain one representative sample of outside noise level for each residence surveyed.

Time of Day Selection for Noise Measurements

Variations with time of day of freeway traffic conditions will cause freeway noise levels to vary over a wide range during a twenty-four hour period. In is important, therefore, to restrict the noise measurements to time of day which can be considered to represent average prevailing noise conditions.

For this purpose, noise levels were sampled over twenty-four hour time periods at various freeway locations using the Environmental Noise Classifier 166/SJ45, using its standard one inch piezoelectric microphone. The measurements started at noon on a working weekday and terminated at noon the following working day. Noise measurements were taken for twenty-five minutes of every consecutive half hour, leaving five minutes each time to record the data, and reset and recalibrate the instrument.

The 166/SJ45 is powered by 115-volt ac. The permanent use over 24 hours of a 12-volt car battery in conjunction with a dc-ac inverter would have required repeated alternations and recharging of batteries. Since this would have been cumbersome, especially at night, arrangements were made instead with owners of gas stations or homes adjacent to freeways to use one of their standard 115-volt ac outlets.

A computer program was used to calculate the mean and variance of each twenty-five minute noise sample as well as the L_{90}, L_{50} and L_{10}.

A result is shown in Figure 3 which was obtained at the Santa Monica freeway. This result is typical of other results obtained by the same method. Based on these results it was decided to conduct community noise measurements in the time period from 8:45 a.m. to 4:30 p.m.

Selection and Training of Field Operators

All field operators selected for this study had either acquired their Ph.D. or were doctoral candidates in engineering or the physical sciences or had at least two years' experience in field noise measurements. Their background experience included teaching graduate level courses, research and industrial experience. Their average age was 28.0 years.

All the field operators attended a training session in which they were given a lecture by an acoustical scientist on noise measurement techniques and were assigned readings on the subject. They were instructed on the subject of noise propagation and the selection of proper spots for taking noise measurements, and on precautions and possible pitfalls for which to watch in the field. They were given very detailed instructions on the use of the instrumentation by the acoustical scientist and by the Bruel and Kjaer sales representative. Toward the end of the training session, they were handed copies of the step by step field operation manual (see Appendix F), as redundant backup material for their field activities. Those operators who were not involved in the twenty-four hour noise sampling program (see preceding section) were also required to accompany an experienced operator in the field for one hour before making their first measurements.

Special Efforts in Minimizing Measurement Errors

All field operators were instructed to take measurements only when the nonfreeway background noise was negligible (see also Appendix F).

24 HRS SOUND PRESSURE LEVEL SAMPLING

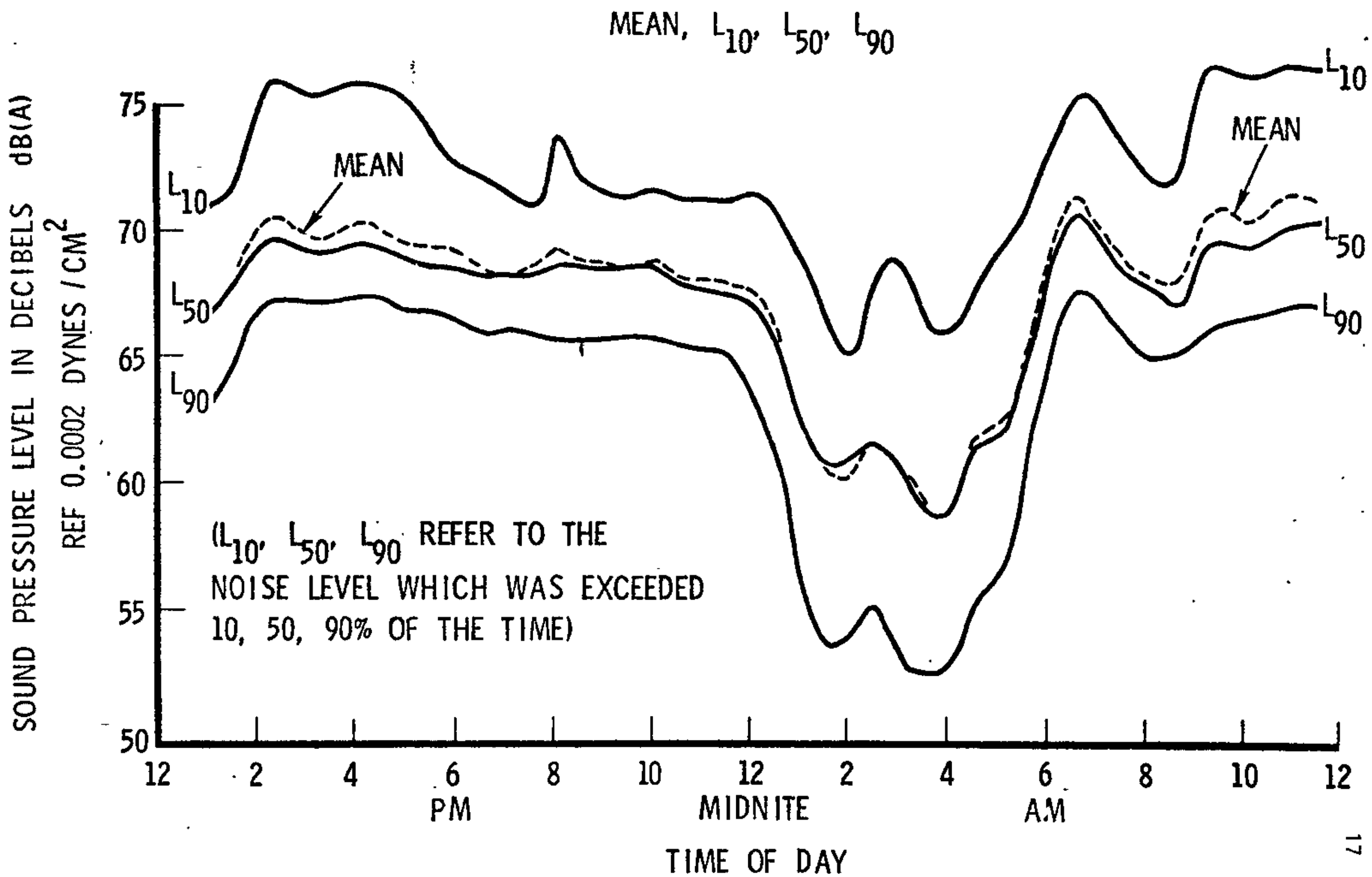


Figure 3.

To avoid measurement errors by improper use of the sound level meter, the field operators were instructed to adjust the attenuator setting of the 2209 so that it showed an average meter scale deflection of -10 dB. In this way, a sound pressure level range from about 30 dB below the mean to 20 dB above the mean was captured by the 2209. This step was taken to assure that the noise levels were always well within the dynamic range of the sound level meter.

There are two ways counts may be lost with the 166/SJ45. One way occurs because up to a maximum of nine samplings per window can be lost due to the fact that the mechanical counter in each window is not updated until ten samplings have been accumulated. This is an inherent limitation of the 166/SJ45. Another way of losing counts is that noise levels which fall below the selected base level, X, are not counted. Therefore, it is important to assure that the base level, X, is set low enough (see Figure A-1).

From the twenty-four hour sampling measurements it was found that the typical noise distribution has a range of about 10-20 dB. Hence, the field operators were instructed to set the base level of the 166/SJ45 so that the maximum of the Sound Pressure Level (SPL) distribution being measured shows in the middle windows of the 166/SJ45. In this way, none, or very few counts are obtained in the first or last window. Due to this precaution, the total count of all windows was always within ± 5 percent of the master window count (thirteenth window). This procedure is reflected in the step by step field measurements procedure (Appendix F).

CHAPTER TWO: SOCIAL SURVEY

Questionnaire Construction

The guidelines for the construction of social surveys have been well laid out by the researchers of aircraft noise, sonic boom and supersonic transport systems. The bridge between air and ground transportation has not been clearly established with reference to noise and community response, but it seems the better part of wisdom to follow the guidelines and profit from the recorded mistakes of aircraft noise researchers. International guidelines (22) for the use of such social surveys for transportation noises emphasize two points: (1) the need for a sample size of at least 50 people in each level of acoustical environment, and (2) the need for establishing the proper frame of reference by means of an introduction which describes the survey sponsorship as a nonprofit or university group and by means of indirect, open-ended questions. The need for indirect questions will be explained more fully in the next section on Spontaneous and Elicited Effects.

The use of a single measure of community response to freeway noise, although convenient, would be a misleading oversimplification of a complex response. There is evidence that an individual's reaction to noise varies from day to day and probably from moment to moment, depending upon various circumstances other than one's current noise environment. An individual may experience a negative reaction to freeway noise when the noise disrupts his activities and behavior. It is also likely that he may have a negative reaction when he hears the noise even if he is not in the midst of an activity. This latter type of reaction is entitled "subjective effects" as opposed to the former type of reaction which is a "behavioral effect." One task of this study is to differentiate the varieties of community response into Subjective and Behavioral Effects, with additional classification if necessary.

The predisposing factors which differentially affect one's tolerance of noise have already been postulated, surveyed or reported in a number of studies of aircraft noise (11, 20, 30) and in at least one study of automotive noise (3). The value of knowing these psychosocial factors is clear for use in predicting the community response of people in advance of making changes in their noise environment. The variables chosen for inclusion in this study are described in the section entitled "Antecedent Conditions."

Finally, we address the problem of response "sets" (or styles) and response biases which occur with the use of rating scales, and the known response set of the lower socio-economic classes to express *no* complaints about transportation noise (7, 21).

Spontaneous and Elicited Effects

Indirect questions are preferable to direct questions about noise for several reasons. The interviewer's suggestion of a negative reaction will spuriously raise the occurrence of such a response from the respondent. Numerous other factors influence a person's response to direct questioning, such as the desire to please, the "demand" characteristics of the situation which suggest the response the examiner is seeking (38), or the effect of being sought out for special observation (Hawthorne effect). A larger proportion of people will complain about a subject once one has called their attention to it. A respondent's spontaneous mention of freeway noise to a general, nonspecific question about neighborhood disturbances is therefore given more weight than a noise response which is elicited by more directed questioning. An example of a direct (elicited) question is, "what is the most annoying feature of the freeway?" Direct questions about freeway noise will not be omitted from this research, but will be termed "elicited effects," in contract to "spontaneous effects."

Although a spontaneous question is less likely than an elicited question to produce an artificially inflated response about one's reaction to noise, it is equally susceptible to many of the above mentioned factors which lead to a biased result. The following steps were taken to minimize the possibility of bias, particuarly from "demand" characteristics:

1. The actual purpose of the questionnaire is presented as part of a survey on neighborhood ecology.

2. The interview begins with very general questions about neighborhoods, allowing for spontaneous mention of causes of dissatisfaction, reason for complaints, etc.

3. Direct questions about noise are embedded among distracting questions which mention smog, schools, etc.

4. Other direct (elicited) questions are reserved for the last part of the interview.

Subjective and Behavioral Effects

Subjective effects include a person's feelings, thoughts and attitudes about freeway noise. Subjective effects have been measured by numerous scales, none of which has received universal usage. Studies of aircraft noise and sonic booms have employed self-reports of respondents' subjective reactions to noises on scales ranging from annoyance (17) and acceptability (2) to intrusiveness (26).

Social surveys of urban and traffic noise have adopted various scaling schemes but the central feature of many surveys has been the direction of people's attention to the rating of "annoyance" in varying degrees (5, 8, 15). The scales have varied in length from 3 to 10 points of annoyance; the present study will contain a 4-point scale of annoyance and add a fifth point termed "pleasant" in order to decrease the suggestibility effect of a scale which is obviously eliciting negative comments.

It has also been suggested that a practical measure of one's subjective reaction can be obtained by examining the daily activities which are disturbed by noise. However, in the event that a negative response does not arise from interruption of activities but from other sources, we have devised subjective scales which differ from behavioral scales (measuring activities or behaviors affected by freeway noise). Spontaneous and elicited scales will be obtained for both subjective and behavioral effects to make a total of four scales. No assumptions are advanced about the independence of the scales, since some correspondence can be expected between one's words and one's behavior. For example, psychological literature (19) predicts a correlation coefficient of .20 to .30 between one's own report of a trait and an objective observer's report of the same trait. This statement carries strong implications about the validity of any research which relies upon a human to supply the answers about his own condition. For this reason, we have not only differentiated the behavioral from the subjective effects, but we have also supplemented questionnaire data with the observations of carefully trained interviewers in as many areas as possible. The interviewers recorded their own impression of speech interference at the respondent's front door and in the respondent's living room with a 3-meter distance between interviewer and respondent. Other observations included the number of open doors and windows, and the existence of household masking sounds.

Antecedent Conditions

Community response to freeway noise is not merely a function of the noise environment, but is influenced by a variety of physical, social, and psychological factors, all of which are not yet known. The factors of interest are those which *cause* the community response; this means that three requirements must be met in order to state that A causes B (13):

1. A and B are statistically associated;
2. A occurs prior to B
3. The association between A and B remains when the effects of other variables which occur prior to both of the original variables are removed.

The social survey questionnaire contains items of the following categories which are likely to be antecedent conditions that are causally related to the measures of community response:

1. Personal characteristics (age, income, sex, race, housing status);
2. Physical characteristics (rooms nearest freeway, side of house facing freeway);
3. Freeway exposure (years of freeway exposure, time spent at home);
4. Awareness of freeway noise;
5. Attitude about freeways (advantage of living near, consideration of freeway planners, importance of freeways, fear of accidents),
6. Voluntary or involuntary coexistence with freeways (involuntary if residence preceded opening of freeway);
7. Neighborhood annoyance (degree of annoyance with other neighborhood features);
8. General irritability (a factor-analyzed scale consisting of items such as "do you have noisy neighbors?")

Other Questionnaire Features

Two other departures from convention are described below--(1) special treatment of the uncomplaining poor and (2) a self reference system for improving a rating scale.

Although ten percent of the population will always complain even at the lowest noise exposures (3), it is generally accepted that the average person will accept every opportunity to avoid criticism during public interviews. The evidence is obtained from several sources that one category of people, those of lower socioeconomic status, are particularly likely to avoid criticising. Lack of any definitive data on the reason for this temperance mitigates against speculation about its cause. In acknowledgement that this reluctance may stem from the reaction to persons in authority, we inserted questions into the questionnaire which attempted to bypass the reactions to two authorities: (1) public officials and (2) the interviewer. An attempt is made to circumvent the normal response to the first authority, public officials, by asking two questions requesting "fantasy" responses: what would one change in the neighborhood with a magic wish, and where would one move if he could move anywhere. The interviewer himself is asked to reduce his authority status by concluding the interview, pens and pencils put away and one foot out the door, with a goodbye and a leading sentence about freeways that enables respondents to make an unguarded, off-the-record response (see Appendix D).

One other departure from convention is noteworthy. Before respondents were asked to rate their annoyance to freeway noise on the rating scale, they were asked to think of the most annoying feature and the most pleasant feature of their neighborhood and to rate freeway noise within this context. A self-anchoring scheme of this type helps to standardize the ratings across respondents who would otherwise disagree as to a criterion for the upper limit of annoyance.

Final Factored Scales

Several forms of the questionnaire were tested before a standard format was adopted. The evolution of the final form is depicted in Figure 4. Certain steps in the procedure were iterated as often as 12 times in efforts to refine the questionnaire items.

The initial selection of questionnaire items for each of the four measures of community response was based on face validity alone. A factor analysis was performed on the intercorrelations among these questionnaire items in an effort to validate the original selection of items for the four measures of community response.

Factor analysis is a technique for determining the underlying dimensions or major classes among large numbers of variables. Factors are hypothetical constructs around which a number of the variables are said to "cluster." The items which cluster around a factor are related to each other and will, as a whole, provide a composite index or a scale; factor correlation coefficients will also serve as the weighting for each item within the scale. A factor analysis can be misleading when used with dichotomized variables such as the type employed in several of the questionnaire items, but the liberty of using the technique is justified on the grounds that the underlying dimensions were already conceived and only in need of confirmation. Care was taken to include only the items which were on the same conceptual level in order to prevent the emergence of a spurious factor composed of items relating to an underlying dimension other than the community response to freeway noise.

Details of the factor scale construction are included in Appendix C. Several of the original items were eliminated from the scales for which they were intended when they failed to "cluster" on the factor matrix. A summary of the items which contribute to each of the final scales can be found in Table D-2. In addition to a scale for Spontaneous Subjective Effects, Elicited Behavorial Effects, and Spontaneous Behavioral Effects, a subset of the latter scale is added to the original scheme. Items in this scale relate to opening of doors or windows and use of outdoor property, and is therefore entitled "outdoor behavioral effects." In addition to the main measures of community response, the results of the factor matrix provided guidelines for developing measures of Attitude to Freeways and of General Irritability.

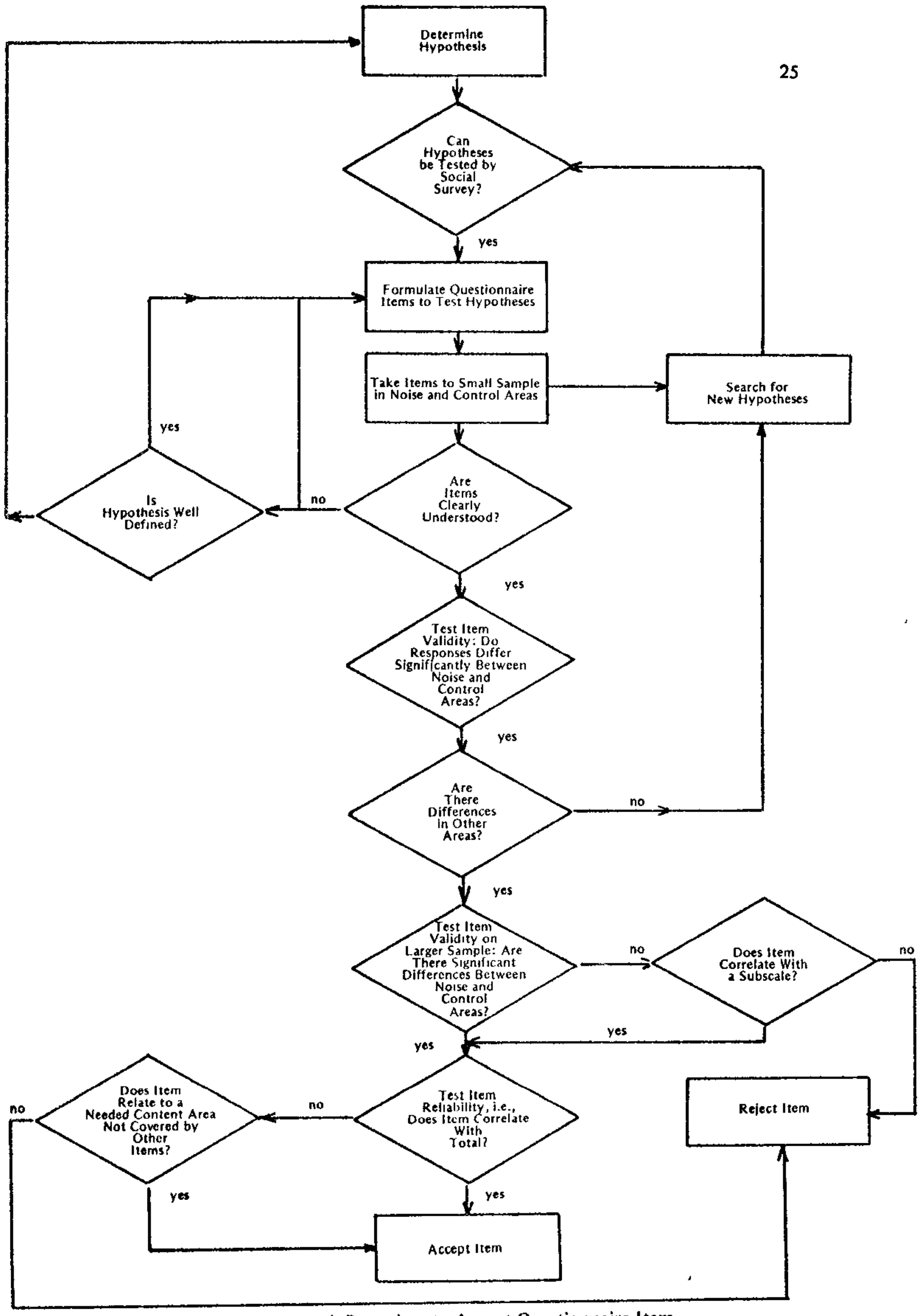


Figure 4. Procedure to Accept Questionnaire Item.

Survey Sampling

Sample Size

A sample size of 1000 was arbitrarily selected as the original goal. This was later necessarily reduced because of equipment delivery delays. Eight hundred and one interviews were eventually obtained; 46 were discarded due to missing data, and 59 interviews were taken from newly completed freeways and were therefore not comparable to all other interviews. Usable interviews totalled 696. A breakdown of the 696 interviews among the major categories of home location can be seen in Table 8.

Freeway Homes

To our knowledge no information is available on the demographic characteristics of the population of people who live near the freeways in Los Angeles County. Every effort was made to secure a random sample of this population so that we could provide these statistics, although the major reason for seeking a random sample is to meet the assumptions of inferential statistics and allow generalizations of the sample's results beyond the sample to the entire population.

Aerial photographs of all Los Angeles County freeways, furnished by the local office of the Department of Transportation, were closely examined in order to make a count of the homes in the first two rows from the freeway which met the following criteria:

1. Single-family dwelling;
2. Residence in a neighborhood which has a density of at least four adjacent homes;
3. Dwelling must not be separated from freeway by more than the width of a city street;
4. No nonresidential features for 900 feet.

For the sake of simplicity, these homes will be referred to as Freeway Homes.

The final count was 10,255, a number which must be considered an approximation because of difficulties distinguishing single from multiple-family residences by their rooftops. Allowing for an expected 40 percent interview completion rate from all homes sampled (the 40 percent figure was derived from pilot work), 12 percent of the population was sampled to obtain 500 interviews (one-half of the original goal of 1000) in homes directly adjacent to freeways.

The aerial photographs were supplied in 3600-foot segments, and every eighth segment was selected for the survey. In short, a 3600-foot segment (1.1 km.; .7 mi.) was surveyed for every 28,800 feet (8.8 km.; 5.5 mi.) of freeway with freeway homes.

Near Freeway Homes

Aircraft noise surveys have had a wider range of noise exposure with which to work than the studies of ground transportation noise. The restricted range of the freeway noise environments results in a decrease in the variance of the noise measurements. Since reliability can be defined as the ratio of true score variance to observed score variance, or

$$r_{reliability} = 1 - \frac{\sigma^2 error}{\sigma^2 measurements} \qquad (3)$$

then the decrease in variance of the noise measurements contributes to a lowering of reliability estimates in statistical analyses. In an effort to broaden the noise level range, at least at the lower end of the continum, 125 homes were included which were located on streets running perpendicular to the freeway and thereby providing a relatively free field for sound propagation. Other criteria for inclusion in this subsample of Near Freeway Homes consist of the following:

1. Home must be separated from the freeway by at least two homes;

2. Home must not be located more than 300 feet from a freeway home or be separated from the freeway by more than one city block;

3. Home must not be adjacent to or facing a major or "through" street or other unusual feature likely to generate a noise more than 5 dB(A) below the average freeway noise level.

Nonfreeway Control Homes

One hundred ninety-three constitute the control sample. Fifty-nine homes were on newly completed freeways and will be analyzed at a later date. One hundred thirty-four homes were selected from areas within two miles of freeway homes in order to match as many neighborhood characteristics as possible. The very stringent criteria for inclusion into this control group precluded a larger sample size than 134:

1. Single family dwelling;

2. Located in residential (R-1) zone;

3. Must not be adjacent to or facing a major or "through" street;

4. Must not be any unusual features separating the nonfreeway neighborhood from its freeway-proximate mate which would suggest that the character of the neighborhood was different (*e.g.*, railroad tracks or manufacturing zone).

Time Sampling

Surveys were conducted between the hours of 9 a.m. and 9 p.m. Pilot work with a small sample of 28, and a male and female interviewer revealed a time-sex factor. The male interviewer had a greater nonresponse rate (number of refusals/total number of criterion homes on street) in the day than at night, and the reverse was true for the female interviewer. On the basis of these findings, only male interviewers were allowed to survey in the evenings, while female interviewers confined their interviewing to daytime.

Sample Characteristics

Demographic Characteristics

The results obtained from this study of freeway homes can only be said to be true for the entire population of people in Freeway and near Freeway Homes, if the sample has the same proportions of sexes, races, etc., as the entire population of residents of freeway-proximate homes. However, the demographic characteristics of this group of people is not known. Much care was taken to select a random sample of this group so that an estimate of the true characteristics could be made. We have also compared the results of the sample to the 1970 figures for the Los Angeles area. The details of the number and proportion of ages, races, sexes, incomes, renters, and employment are presented in Tables 1 to 7. The interviewers' ratings of respondents' cooperation at the time of interview are also included. In these tables, the Freeway and Near Freeway Homes are referred to as the Freeway Sample and are compared to homes in the Nonfreeway areas.

The Freeway and Nonfreeway (control) Samples differ in income, housing status, and percentage of Spanish-Americans (t-test, $p < .010$, $.001$, $.008$ respectively). These three demographic characteristics were thoroughly tested for their influence on community reactions to freeway noise, and were found to have no significant effects of either a direct or indirect nature. The exact nature of these tests is described in Chapter Three.

Statistical tests were not calculated for differences between the sample data and the government census figures; however, it seems clear that both the Freeway sample and Nonfreeway sample differ from the census figures for Los Angeles County on every demographic category except age and race. It is not surprising that the Freeway and NonFreeway Samples consisted of a higher proportion of unemployed people and homeowners than the average proportions in the county, because residential areas were purposely selected and because unemployed people are more likely than employed people to be at home for interviews. The preponderance of females is also likely to be a result of sampling and *not* an indication that two-thirds of the people who live near freeways are female.

Table 1. Sex Distribution for Freeway Sample, Nonfreeway Sample and Los Angeles Area (1970 Census). Figures indicate percent within sample; actual number of people is in parentheses.

		Freeway	Nonfreeway	Census
Sex:	Male	33.9% (N = 208)	37.1% (N = 69)	47.4% (N = 2, 377, 391)
	Female	66.1% (N = 405)	62.9% (N = 117)	52.6% (N = 2, 638, 884)

Table 2. Housing Status for Freeway Sample, Nonfreeway Sample and Los Angeles Area (1970 Census). Figures indicate percent within each sample; actual number of people is in parenthesis.

		Freeway	Nonfreeway	Census
Housing Status:				
	Own	80.6% (N = 495)	89.8% (N = 167)	48.5% (N = 1, 179, 943)
	Rent	19.4% (N = 119)	10.2% (N = 19)	51.5% (N = 1, 252, 83)

Table 3. Distribution of Cooperation Scores for Freeway Sample and Nonfreeway Sample. Figures indicate percent within each sample; actual number of people is in parenthesis.

	Freeway	Nonfreeway
Cooperation Scores:		
1. Eager	19.1% (N = 115)	8.7% (N = 16)
2. Pleasant	69.1% (N = 416)	84.2% (N = 154)
3. Neutral	10.5% (N = 63)	6.0% (N = 11)
4. Unpleasant	1.3% (N = 8)	1.1% (N = 2)

Table 4. Income Distribution of Freeway Sample, Nonfreeway Sample and Los Angeles Area (1970 Census). Figures indicate percent within each sample; actual number of people is in parentheses.

	Freeway	Nonfreeway	Census
Income Category:			
Under $4000	15.8% (N = 88)	9.6% (N = 15)	13.4% (N = 207, 638)
$4000-4999	(6.5% (N = 36)	4.5% (N = 7)	4.8% (N = 74, 425)
$5000-7999	12.9% (N = 72)	12.8% (N = 20)	17.9% (N = 277, 415)
$8000-9999	13.8% (N = 77)	12.8% (N = 20)	14.1% (N = 217, 943)
$10,000-14,999	31.2% (N = 174)	34.0% (N = 53)	17.3% (N = 268, 669)
$15,000-19,999	19.6% (N = 109)	26.3% (N = 41)	24.3% (N = 376, 204)
$20,000 +	0% (N = 0)	0% (N = 0)	8.1% (N = 126, 347)
Mean	$7,789	$9,079	$12,783

Table 5. Race Distribution of Freeway Sample, Nonfreeway Sample and Los Angeles Area (1970 Census). Figures indicate percent within each sample; actual number of people is in parentheses.

	Freeway	Nonfreeway	Census
Race			
Caucasian	75.9% (N = 465)	81.6% (N = 151)	67.4% (N = 4, 742, 125)
Black	8.5% (N = 52)	7.0% (N = 13)	10.8% (N = 762, 925)
Spanish-American	13.2% (N = 81)	7.0% (N = 13)	18.3% (N = 1, 289, 311)
Other	2.4% (N = 15)	4.3% (N = 8)	3.5% (N = 242, 96)

Table 6. Employment Status Distribution (By Sex) of Freeway Sample, Nonfreeway Sample and Los Angeles Area (1970 Census). Figures indicate percent within each sample; actual number of people is in parentheses.

	Freeway	Nonfreeway	Census
Employment Status, Sex			
Males (over 16 years)			
Employed	68.3% (N = 142)	71.0% (N = 49)	78.8% (N = 1, 872, 637)
Unemployed	31.7% (N = 66)	29.0% (N = 20)	21.2% (N = 504, 754)
Females (over 16 years)			
Employed	27.2% (N = 110)	31.6% (N = 37)	44.6% (N = 1, 175, 229)
Uemployed	72.8% (N = 295)	68.4% (N = 80)	55.4% (N = 1, 426, 655

Table 7. Age Distribution of Freeway Sample, Nonfreeway Sample and Los Angeles Area (1970 Census). Figures indicate percent within each sample; actual number of people is in parenthesis.

Age Category:	Freeway	Nonfreeway	Census
11-20	10.9% (N = 67)	7.6% (N = 14)	10.9% (N = 230, 125)
21-24	6.8% (N = 42)	4.9% (N = 9)	11.7% (N = 246,377)
25-34	21.9% (N = 135)	20.0% (N = 37)	18.9% (N = 397, 241)
35-44	16.7% (N = 103)	21.6% (N = 35)	16.2% (N = 342, 27)
45-54	17.4% (N = 107)	21.6% (N = 40)	16.3% (N = 343, 883)
55-64	14.0% (N = 86)	16.8% (N = 31)	12.5% (N = 264, 81)
65 +	12.2% (N = 75)	10.3% (N = 19)	13.5% (N = 283, 395)

Noise Related Survey Characteristics

The noise survey was performed for 562 houses located close to freeways and for a control sample of 134 houses far away from freeways. Table 8 shows the distribution of all homes in the sample among the categories of home location, and the home orientation relative to the freeway of the freeway homes in the first two rows. This summary shows that 42 percent of the freeway homes are in the first row of homes near the freeway (with the rear of the house facing the freeway) and 34 percent are in the second row of homes relative to the freeway, in which case their front typically faces the freeway and they are separated from the freeway by a surface street or vacant land.

Table 9 shows the mean value and standard deviation of each of the different candidate noise measures for the entire sample of 696 homes in the freeway and control samples. This table demonstrates the inherent differences among the various noise measures when computed from one and the same noise sample. It is noteworthy, for example, that the L_{10} exceeds the L_{50} by approximately 5 dB(A) in all freeway noise cases, but it exceeds the L_{50} by approximately 7.5 dB(A) in the control cases where freeway noise is absent. Table 9 also implies that noise levels are not simply related to the inverse square of the distance from the freeway.

Homes with their front facing the freeway always have a surface street and often another row of homes between them and the freeway. Nevertheless, they tend to have higher noise levels than the other homes adjacent to freeways. This may be attributable to the fact that of all the homes adjacent to freeways, 66 percent were adjacent to elevated freeways; homes with their rear or side facing the freeway are so close to the freeway that they lie partially in the "noise shadow" of the elevated freeway.

Table 8. Distribution of all Surveyed Homes in Sample Among the Three Categories of Home Location, and Including the Home Orientation Relative to Freeway for Freeway-Adjacent Homes.

Location of Home	Number of Homes	Percent of Total Sample
Freeway-Adjacent Homes		
Rear Faces Freeway	151	
Front Faces Freeway	184	
Side Faces Freeway	92	
Indeterminable	11	
Subtotal	438	62.9%
Near-Freeway Homes		
From the third row to one city block from freeway	124	17.8%
Matched Nonfreeway (Control Homes)	134	19.3%
Total	696	100.0%

Table 9. Mean Value and Standard Deviation of Each Candidate Noise Measure for all Categories of Home Location.

LOCATION OF HOME
(All Figures are Derived from dB(A))

	Freeway-Adjacent Homes									
	Rear Faces Fwy		Front Faces Fwy		Side Faces Fwy		Near Freeway Homes		Matched Non-Freeway Control	
Noise Measure	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
L_{10}	69.59	7.36	72.33	6.94	69.12	5.87	65.06	8.67	58.70	4.44
L_{50}	64.05	7.57	67.02	7.23	63.93	6.59	59.95	8.83	51.21	4.91
L_{90}	60.49	7.80	63.43	7.09	60.50	6.62	56.28	8.80	47.45	5.16
Mean	64.59	7.48	67.52	7.06	64.41	6.33	60.39	8.73	52.32	4.74
TNI	66.91	9.41	69.01	9.36	64.99	9.29	61.34	10.45	62.45	10.25
NPL	74.61	7.33	77.29	7.36	73.90	6.13	70.03	8.85	64.72	5.02
DIL	66.38	7.23	69.32	7.00	66.08	6.12	62.05	8.74	54.18	4.45
DEL	68.71	7.42	71.66	7.11	68.62	6.24	64.45	8.41	56.65	4.10

Social Survey Data Collection

Interviewer Selection

The surveys used by the Social Survey Data Collectors (interviewers) were constructed to maximize interviewer productivity and accuracy. The survey format is included in Appendix D.

Both males and females were selected as interviewers to randomize any differences in interview responses due to sex of interviewer. Five females and seven males with a mean age of 29.9 served as interviewers. The ethnic diversity of Los Angeles County residents required that special attention be given to the selection of interviewers who would be allowed entrance into all homes, particularly of the black and Spanish-American residents. Two interviewers were bilingual but 50 percent of all interviewers were conversant in Spanish. (A brief Spanish glossary of relevant words from the questionnaire was given to every interviewer.) One black male interviewer was hired after other interviewers were met with a zero response rate in integrated neighborhoods. The new black interviewer received an average nonresponse rate of 5.2 in those same neighborhoods, which compares favorably with the overall average nonresponse rate of 10.2 for all interviewers (see page 28 for definition of nonresponse rate). He was given coverage of all integrated neighborhoods, although he was not exclusively assigned to integrated areas.

The selection criteria for the interviewers included the pursuit of a doctorate in the psychological or social sciences with experience in psychiatric counseling-interviewing, or at least three years' interviewing-counseling experience if the background were less than the doctoral level. A summary of the interviewers' qualifications is contained in Appendix F.

Interviewer Training

Prospective interviewers could be terminated at any point in the two-week training program. Training consisted of a half day in the laboratory and a trip to the University's Communication Disorders Clinic for an audiometer test. Interviewers rehearsed the interview with each other (role playing) to help familiarize themselves with the wording and to experience the questions from the respondents' point of view. Interviewers were required to perform a practice interview with their supervisor before they were permitted to go into the field. Supervisors commented on errors, style, warmth, sincerity, etc., and gave to the successful "graduates" an identification card and personalized debriefing thankyou letters to be left with every respondent.

After the interviewers completed a "test" assignment in the field—usually requiring less than a week and the collection of three interviews—they reported back to their supervisor for a review of their work. If the work was deemed satisfactory, they were assigned as fulltime interviewers. However, the point was made clear that quality and not quantity was the study's objective. As it turned out, our interviewers worked methodically and at an unhurried pace in accomplishing their interviews.

Interviewer Supervision

In order to provide continuity and, most importantly, almost constant supervisory control, a twenty-four hour telephone answering service was made available to the interviewers. The questions and situations raised by the interviewers in their telephone calls from the field ranged over the full spectrum of human interactions. As it appears that the "answering service" approach was innovative and effective, we would plan to use the concept on any future studies using field interviewers.

Additionally, all interviewers were asked to meet once a week, or more often at their discretion, with their supervisor. These sessions proved invaluable in assessing the interviewers' performance and current psychological frame of reference for their ongoing work with the study.

CHAPTER THREE: COMMUNITY RESPONSE TO FREEWAY NOISE

Evaluation of Noise Measures

Noise Data Format

As described in "Instrument Characteristics," the output of the Environmental Noise Classifier is given in terms of time during which the noise level fell into 12 discrete noise level bands. The output of this instrument is thus a statistical distribution of the noise levels. Figure 5 presents a typical output obtained with this instrument. The particular output shown was measured as part of the 24-hour time sampling of noise levels (see "Time of Day Selection for Noise Measurements"). The ordinates in Figure 5 add up to approximately 250, reflecting the fact that 25-minute sampling periods were then used.

The results demonstrated by Figure 5 were keypunched into data cards and thus became available in a computer-compatible data format.

Computation of Candidate Noise Measures

A computer program was written which computed all the candidate noise measures defined in the "Selection of Candidate Noise Measures." The L_{10}, L_{50}, and L_{90} were calculated according to the formula

$$L_n = U_i - \left[\frac{F \times J}{100} - f\right] \frac{W_i}{C_i} \tag{4}$$

L_n = Raw score equivalent to percentile n

J = Percentile of interest (*e.g.*, 10, 50, 90) expressed in whole integer

F = Total cumulative count

U_i = Upper boundary of raw score interval for $\frac{F \times J}{100}$

f = Sum of all counts below *i*th interval

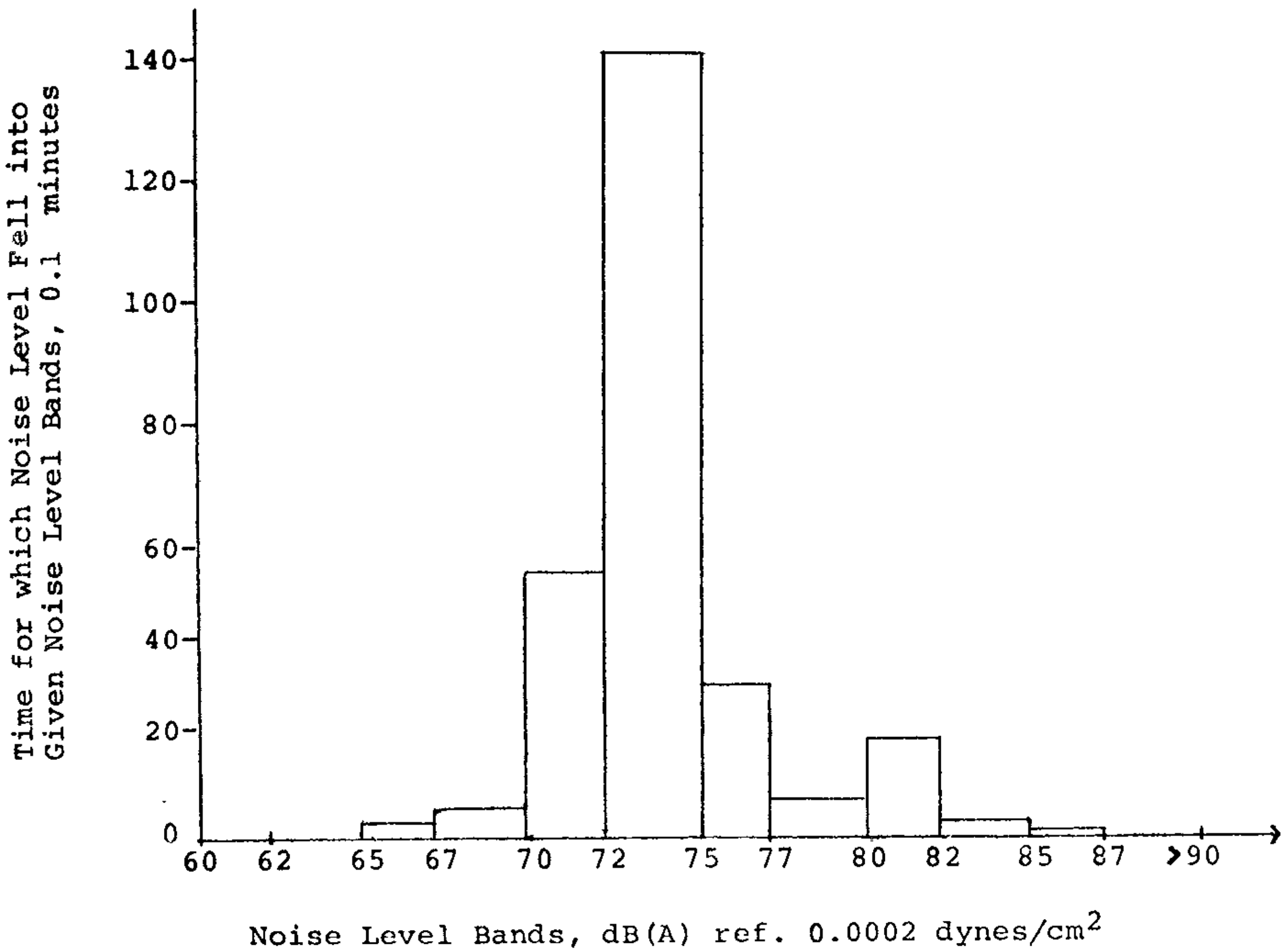


Figure 5. A Typical Noise Sample Obtained with the Environmental Noise Classifier, Bruel & Kjaer Model 166/SJ45.

W_i = Width of ith interval

C_i = Count in the ith interval

The mean and variance of the noise level distributions were also computed. Based on these results all other candidate noise measures were then computed using the definitions given in the "Selection of Candidate Noise Measures."

Comparative Evaluation of Candidate Noise Measures

All the candidate noise measures adapted in this study were intercorrelated with Pearson correlation coefficients. The intercorrelations among the various noise measures obtained in this study are summarized in Table 10.

The results show high correlations among most of the candidate noise measures with one notable exception: the Traffic Noise Index correlates relatively low with all the other candidate noise measures.

Optimum Predictor of Community Response

Each of the measures of community response was correlated with all candidate noise measures in order to determine the noise measure which correlates highest, *i.e.*, is the best predictor of each measure of community response. The results are shown in Table 11. NPL is the best predictor for spontaneously mentioned responses and L_{50} for the elicited responses. L_{50} is also a good predictor for Outdoor Behavior but L_{90} has the highest correlation with this scale. The optimum predictor varies for each of the measures of community response. The experimental measures, DIL and DEL, did not demonstrate superiority over existing measures as predictors of community response.

The best predictor for each of the measures of community response will be employed in the regression equations in a later section, but certain statistical comparisons to follow in this report would be facilitated by using a common noise measure for all comparisons, instead of using the best predictors. The median noise level, L_{50}, will serve this purpose, because it has the advantage of simplicity over NPL.

Table 10. Matrix of Intercorrelations Between All Candidate Noise Measures.

PEARSON CORRELATIONS

	L_{10}	L_{50}	L_{90}	MEAN	TNI	NPL	DIL	DEL
L_{10}	1.000							
L_{50}	.972	1.000						
L_{90}	.964	.989	1.000					
MEAN	.983	.997	.993	1.000				
TNI	.768	.622	.572	.647	1.000			
NPL	.980	.940	.906	.947	.848	1.000		
DIL	.984	.991	.975	.992	.690	.964	1.000	
DEL	.979	.989	.978	.990	.673	.955	.994	1.000

Table 11. Matrix of Pearson Correlations Between Measures of Community Response and Candidate Noise Measures.

	Noise Measures dB(A)							
	L_{10}	L_{50}	L_{90}	Mean	TNI	NPL	DIL	DEL
COMMUNITY RESPONSE								
Spontaneous Behavioral	.119	.120	.111	.117	.101	<u>.127</u>	.118	.116
Spontaneous Subjective	.276	.263	.256	.264	.237	<u>.278</u>	.268	.275
Elicited Subjective	.296	<u>.304</u>	.294	.299	.207	.295	.299	.298
Elicited Behavioral	.168	<u>.177</u>	.168	.172	.118	.171	.173	.169
Outdoor Behavior	.250	.287	<u>.289</u>	.283	.079	.227	.277	.273

The Relation of Community Response to Noise Exposure

Stratification of Median Noise Levels

The correlations between noise measures and measures of community response as shown in Table 11, are not impressively high. The level of noise to which a person is exposed accounts for only 9 percent of the variance, at best. This means that a person's response is influenced by a number of other factors besides the actual noise level. Without the ability to control those other factors, one can still examine the "average" response if the averages are based on a large, random sample. The freeway sample is divided into noise strata groups of approximately 50 people each, based upon the median (L_{50}) noise measure. The midpoints (and the range) of the noise strata are 56 (54-58), 60 (58-62), 64 (62-66), 68 (66-70), and 72 (70-74). The median of all noise measures below 54 was 51.29 and the median of all scores above 74 was 79.85.

Noise is Most Salient Feature

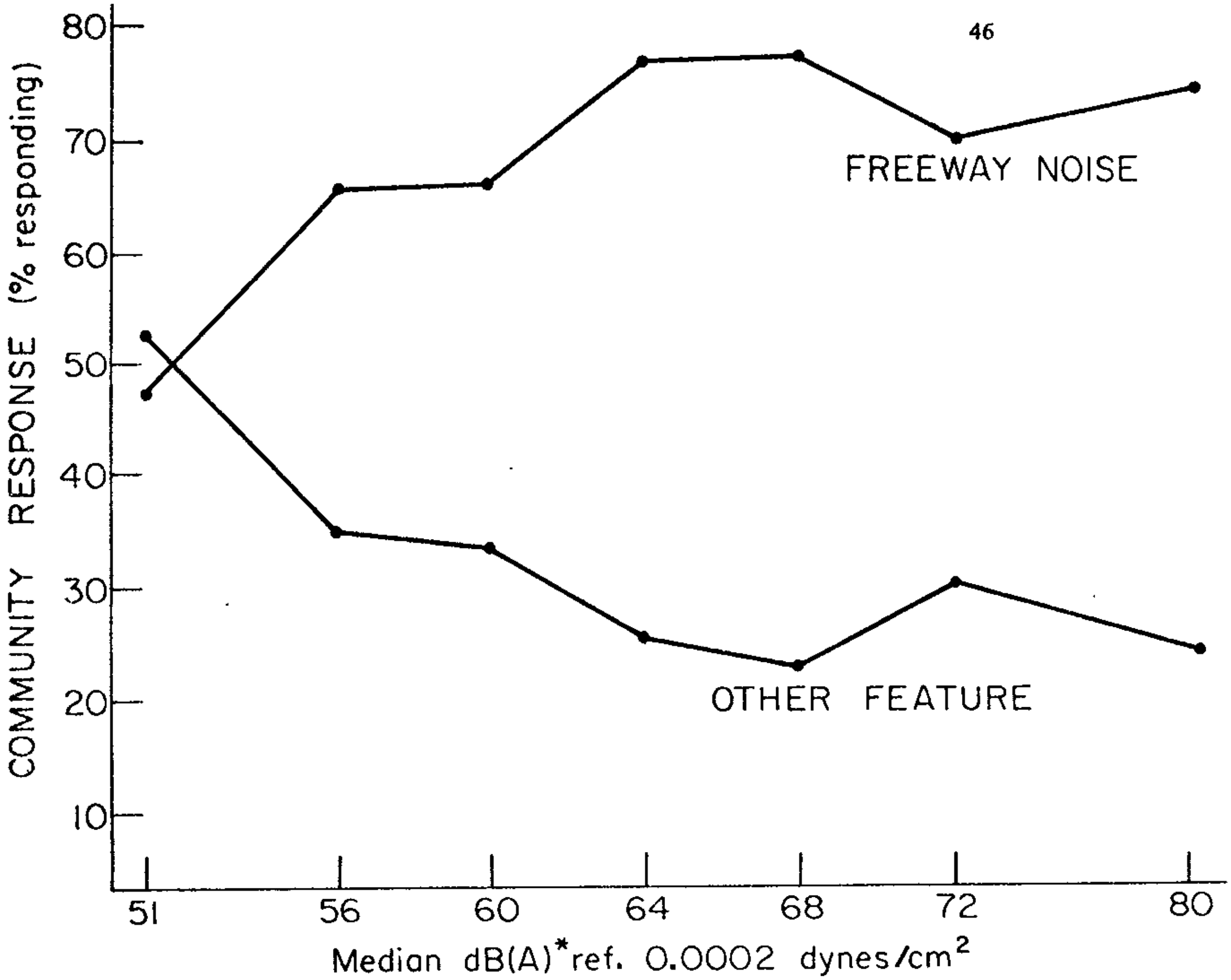
Rather than assume that noise is the most salient feature of the freeway, we directed our attention to a comparison of all the noxious elements of freeways. A summary of respondents' opinions about the most annoying freeway feature is contained in Table 12. Noise in general and truck noise are listed most frequently as the most annoying aspect of freeways for people who live near them; however, a control group of Los Angeles residents, not unexpectedly, described the crowded condition on the freeway as their major source of annoyance. The relative standing of freeway noise among the freeway areas is more clearly seen in Figure 6, where noise in general is combined with truck noise and compared across the different noise strata. The community response rises to 70 percent for people who live in an environment with median noise level exceeding 63 dB(A); only at the lowest noise levels do other noxious freeway features predominate over freeway noise as the most annoying feature of freeways.

Comparative Analysis of Measures of Community Response

The average scores for the measures of community response were computed for each of the noise stratum and the group differences were tested by analysis of variance. (See Table 13.)

Table 12. Most Annoying Freeway Feature

	Percentage Mentioning Features	
	Freeway Areas	Control Areas
Noise in General	36.5	8.8
Truck Noise	25.8	1.5
Dirt/Smog	8.5	10.3
Accidents	6.5	0
Appearance	2.7	1.5
Crowding	1.3	48.5
Construction Workers	1.1	0
Other	3.6	14.7
No response	13.9	14.7
	100%	100%



* Median dB(A) is used because of its superior correlation with community response. L_{10} is approximately 5dB greater than median dB(A).

Figure 6. Community Opinion of Most Annoying Freeway Feature.

Outdoor Behavior is reported only for interviews taken in the summer (July through September). The mean score for each measure of community response increased with each increasing noise level. The other factor scales, Attitude to Freeways and General Irritation, also produced significantly increasing mean scores for successively higher noise strata. Table 13 presents the F-test for the analysis of variance of the mean scores. The significance level of the analysis of variance expresses the probability that the mean scores differed by chance alone.

The noise measures were all converted to the same scale by a Z-score transformation with mean equal to zero and standard deviation equal to 100. The Spontaneously Mentioned Effects are graphed in Figure 7 with the line of best fit drawn for each measure. Respondents living in a noise environment with median sound pressure level below 66dB(A) report that their behaviors are interrupted or affected by freeway noise, but they do not offer words of annoyance or other subjective disturbance. It is only in noise levels above 66 dB(A) that their verbalizations of subjective reaction exceed their report of activity interruption. Only the Spontaneously Mentioned measures are shown in Figure 7, but the Elicited Effects have a nearly identical relation with noise exposure.

Detailed Identification of Community Response

It was not expected that every *individual* item which contributed to each of the measures of community response would also differ among the noise strata, but this was found to be true for a large majority of the items. Questionnaire items are usually categorical rather than equal-interval measures, and are therefore analyzed by a chi-square procedure. The listing of questionnaire items for each measure of community response, the chi-square statistic and its associated probability is detailed in Appendix D.

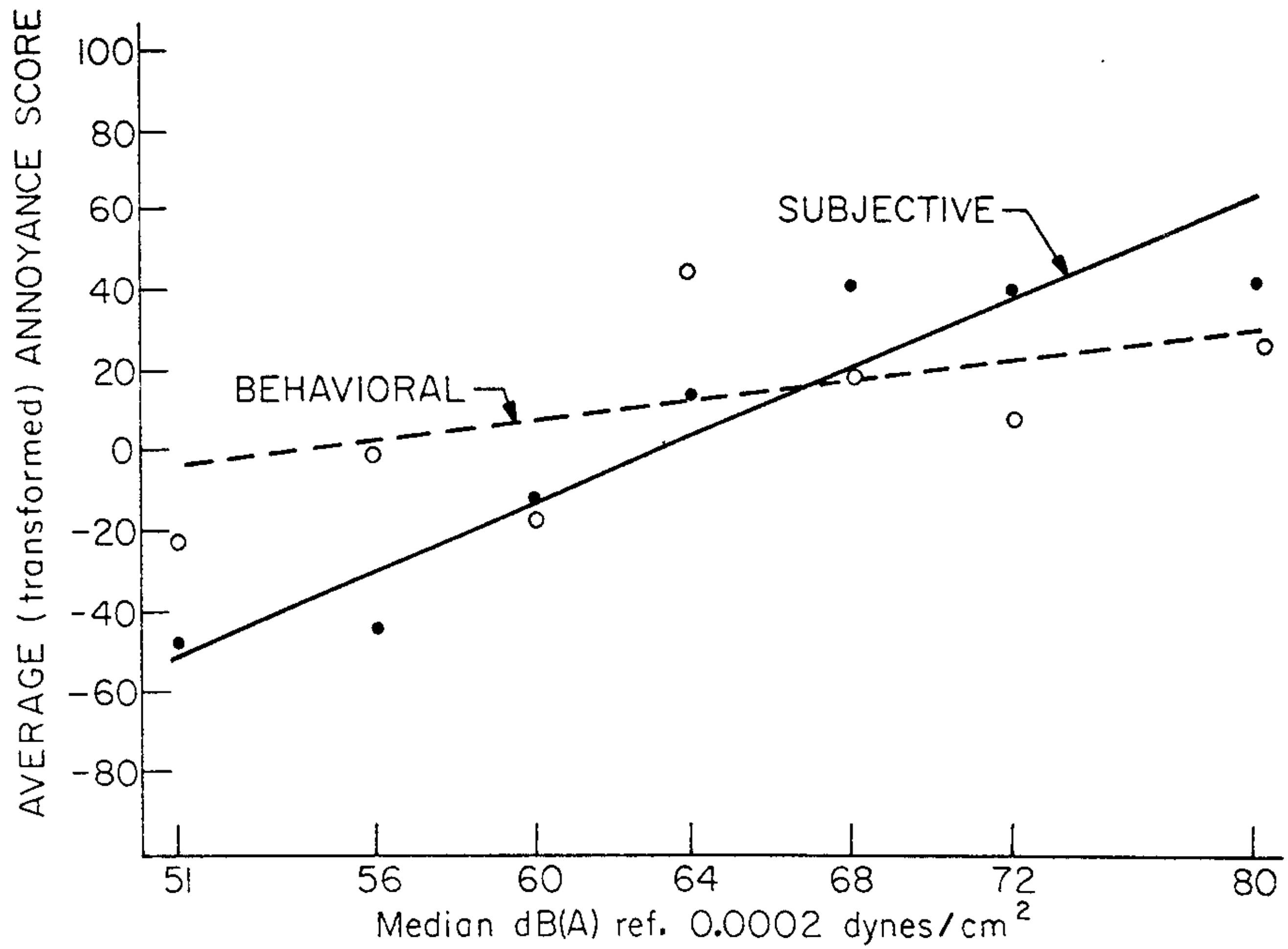
The Spontaneous Subjective Measure contains items such as major cause of dissatisfaction with neighborhood and reasons for complaining or moving. This measure also includes the "fantasy" question about having the magic to make one change in the neighborhood. The percent of people mentioning the freeway as the one thing with which they are most dissatisfied is graphed in Figure 8. At a median noise level of 60 dB(A), over 25 percent of the people report their dissatisfaction with freeway noise or their desire to change the freeway noise. This figure increases to 40 to 50 percent for the median noise levels in excess of 76 dB(A). The percent of people who list freeway noise as the main reason for wanting to

Table 13. Mean Community Response Scores for Each Noise Stratum and Test of Significance Between Community Response Scores.

Community Response	Mean Score for Each Noise Stratum (Median dB(A)) 51	56	60	64	68	72	80	Analysis of Variance F-test	sign.*
Spontaneous Subjective	0.78	0.77	1.01	1.20	1.29	1.28	1.34	8.52	.01
Spontaneous Behavioral	1.64	1.71	1.65	1.73	1.78	1.74	1.79	2.20	.04
Elicited Subjective	0.32	0.41	0.49	0.49	0.55	0.52	0.55	12.94	.01
Elicited Behavioral	0.93	1.00	1.09	1.14	1.13	1.14	1.13	5.02	.01
Outdoor Behavior	.00	0.14	0.25	0.38	0.39	0.24	0.56	8.89	.01
Other Measures									
Attitude to Freeways	2.22	2.51	2.51	2.49	2.58	2.46	2.56	2.12	.05
General Irritation	0.54	0.61	0.65	0.65	0.67	0.62	0.67	4.72	.01

*Probability that mean scores differ by chance alone (df = 6, 554)

N.S. is assumed where significance > .10.



Dots represent the mean standardized score (● = Subjective, O = Behavioral) for respondents within each noise stratum. The overall mean is 0 and σ is 100.

Figure 7. Relation Between Median Noise Level and Spontaneously Mentioned Community Reactions

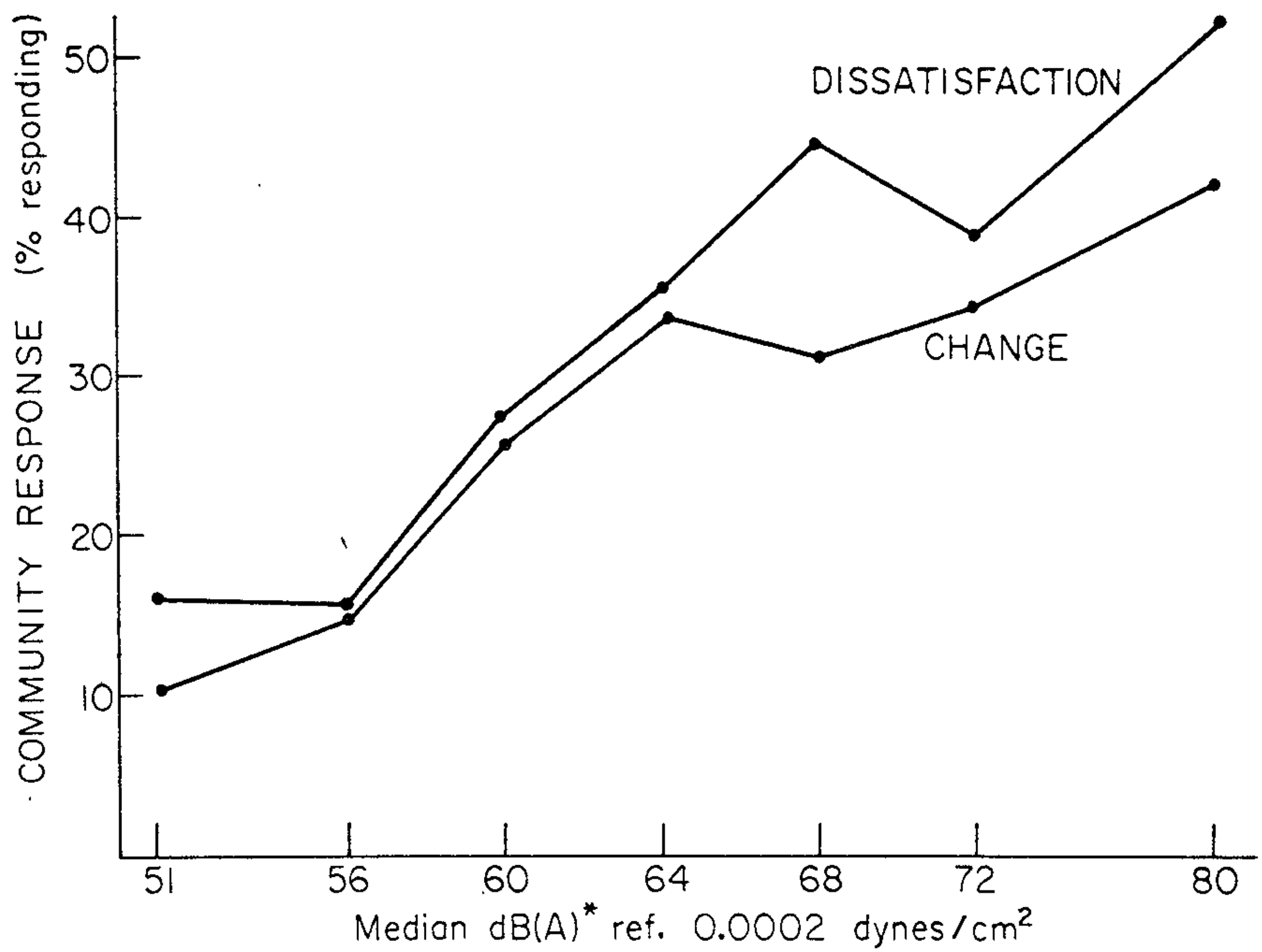
move out of a neighborhood varies from 10 to 25 percent.

The Spontaneous Behaviorial Measure contains items describing how daily life is affected by freeway noise. When all the activities which respondents mentioned are examined for commonalities, no one activity appears to be mentioned more often than others. However, the frequency of complaints about interruptions of all activities, taken as a whole, increases with respondents dwelling in increasingly louder noise exposures.

The measure of activity interruption based on elicited rather than spontaneous responses, the Elicited Behavioral Measure of community response is shown, in part, in Figure 9. The disturbances mentioned frequently include conversation, television watching, or sleeping. Twenty-five percent of the respondents report these disturbances at median noise levels between 56 and 58 dB(A), with this figure increasing to 45 percent at median noise levels in excess of 72 dB(A). It is interesting to note that conversational disturbances become increasingly more frequent as the median noise level increases. However, the number of reported disturbances of sleep, television viewing and relaxing begins to level off at median noise levels of approximately 66 dB(A).

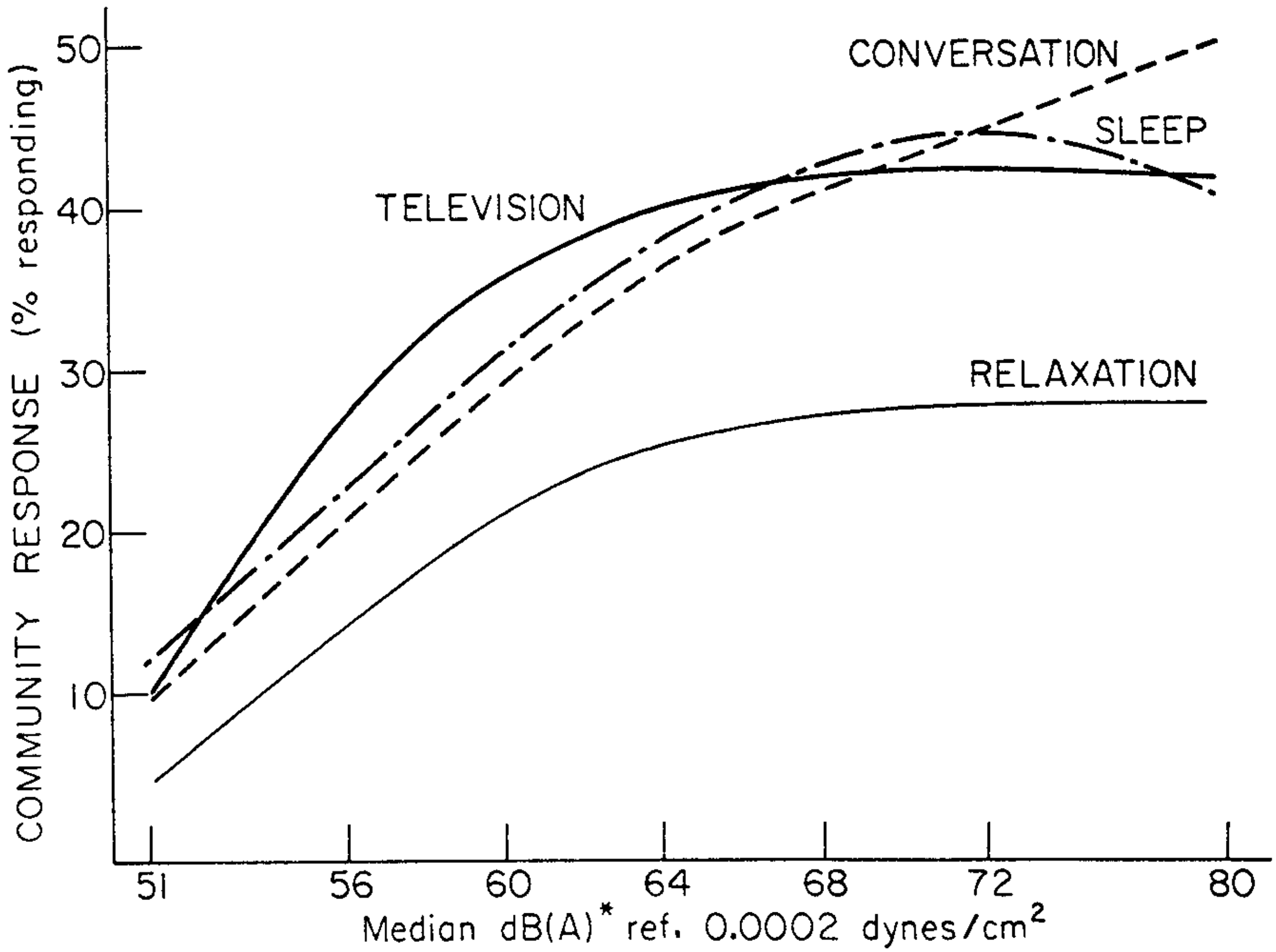
The measure of community response based on elicited responses without reference to activity disruption, the Elicited Subjective Measure, included items about annoying freeway features, adapting to freeway noise, and a self-rating of freeway noise. The latter item is beset with all the typical biases of attitude rating scales, but it is useful as a basis of comparison with the other measures and with other social surveys of comparable methodology. Figure 10 displays the regression of the rating scale on the median noise level and the regression of the noise level on the rating score. A score of 3.0 corresponds with the qualitative rating of "a little annoyed" and respondents living in the noise stratum from 58 to 62 dB(A) report, on the average, an annoyance score of 3.3. The respondents living in the loudest noise levels which were measured in this survey reported an average annoyance score of 4.02 which corresponds with a qualitative rating of "moderately annoyed."

The average median noise level for all respondents who reported that they were a little annoyed with the freeway noise is 64.1 dB(A). One hundred seventy-eight respondents reported that they were "very annoyed" with freeway noise. The average median noise level for these 178 people is 67.1 dB(A).



* Median dB(A) is used because of it superior correlation with community response. L_{10} is approximately 5dB greater than median dB(A).

Figure 8. Freeway Noise Spontaneously Mentioned as Main Cause of Dissatisfaction or the Main Feature People Would Like to Change in Their Neighborhood.



* Median dB(A) is used because of its superior correlation with community response. L_{10} is approximately 5dB greater than median dB(A).

Figure 9. Relation Between Activity Disturbance and Noise Level.

The items which constitute the Outdoor Behavioral Measure of community response do not follow a pattern which is consistent with the other measures or with hypotheses about the effects of freeway noise. The proportion of people who report that they seldom use their outdoor property increases (from 40 to 53 percent for residents living in median noise levels above 66 dB(A)) with increasingly louder noise exposure, just as one might expect. However, the people in the louder noise exposures do *not* close their doors and windows to the noise, *nor* do they close out the freeway sounds from their bedroom at night. Figure 11 portrays the relationship between the median noise levels and the percentage of people who reported that they kept their bedroom windows open at night. Less than 40 percent of the people in the lowest noise levels reported that they kept their bedroom windows open at night, but this figure rose to 65 percent for people living in the median noise levels of 72 dB(A). As the Outdoor Behavioral Measure consists of summer interviews and is based on a small sample size, generalizations cannot be made. Nevertheless, because of the unusual and unexpected direction of the finding, further research should be considered.

Locus of the Greatest Community Response

One gets the impression, from Figures 7 through 11, that the community response is most prevalent among people who live in the loudest noise levels. However, there are few people who live in the highest noise levels. If the present survey is representative of the noise levels in residential areas of the entire county of Los Angeles, then we can assume that approximately 20 percent of all homes near and adjacent to freeways are dwelling in median noise levels in excess of 70 dB(A), and 80 percent dwell in lesser noise levels. Nearly 30 percent of the present sample live in the noise stratum from 58 to 62 dB(A), and, consequently, in terms of absolute numbers, the greatest numbers of people who are annoyed by the freeway noise will live in this noise stratum.

Table 14 demonstrates this fact for one measure of community response—the spontaneous subjective effect. A vast majority of people in the highest noise stratum are annoyed by freeway noise (see column 2 of Table 14), but the noise stratum with the greatest *numbers* of annoyed people is 58 to 62 dB(A) (see column 4 of Table 14).

It may be instructive to examine the locus of the greatest community response to freeway noise in relation to the home locations as well as to the actual noise levels. Table 14A presents a breakdown of the home locations in each noise stratum. The majority of homes

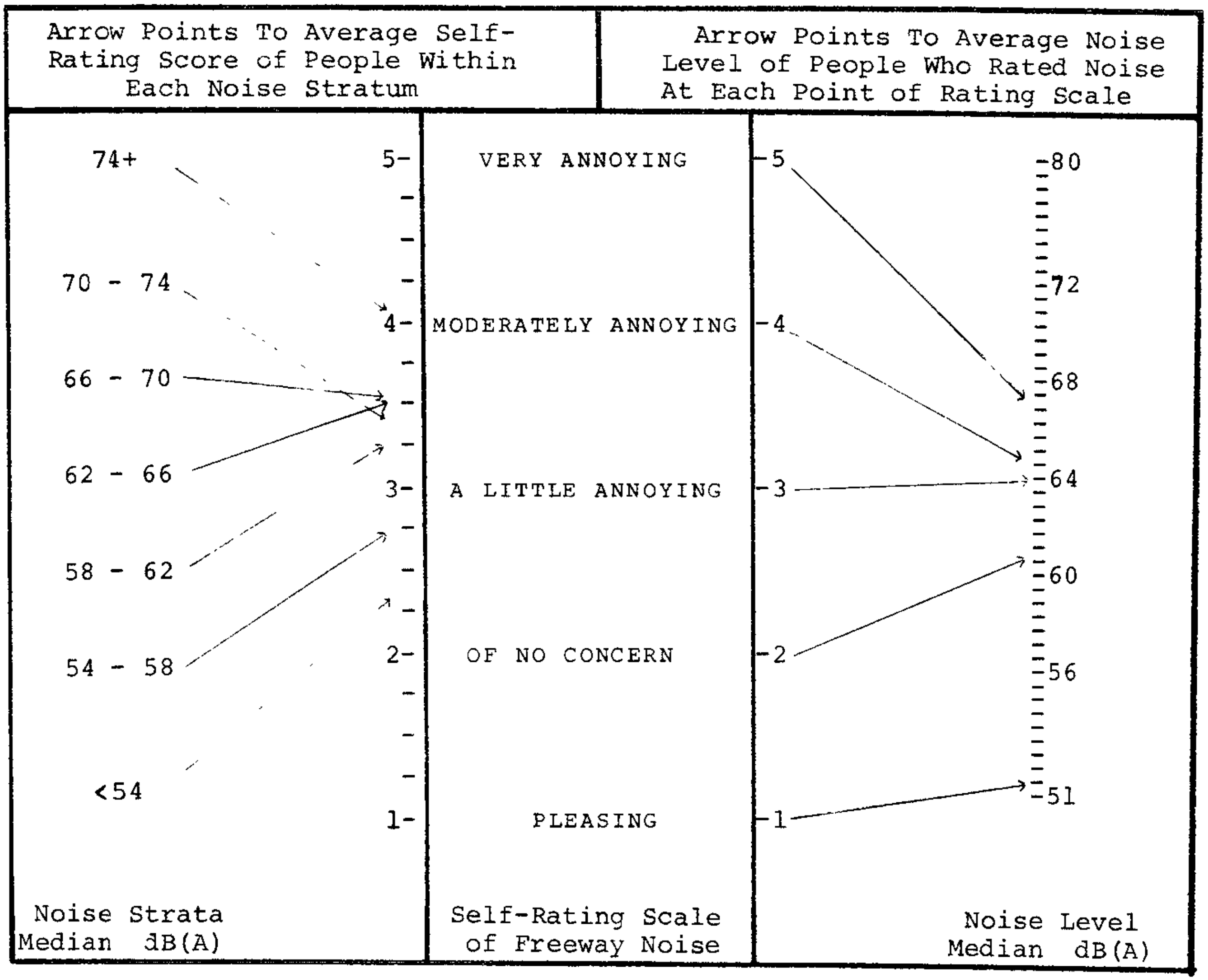
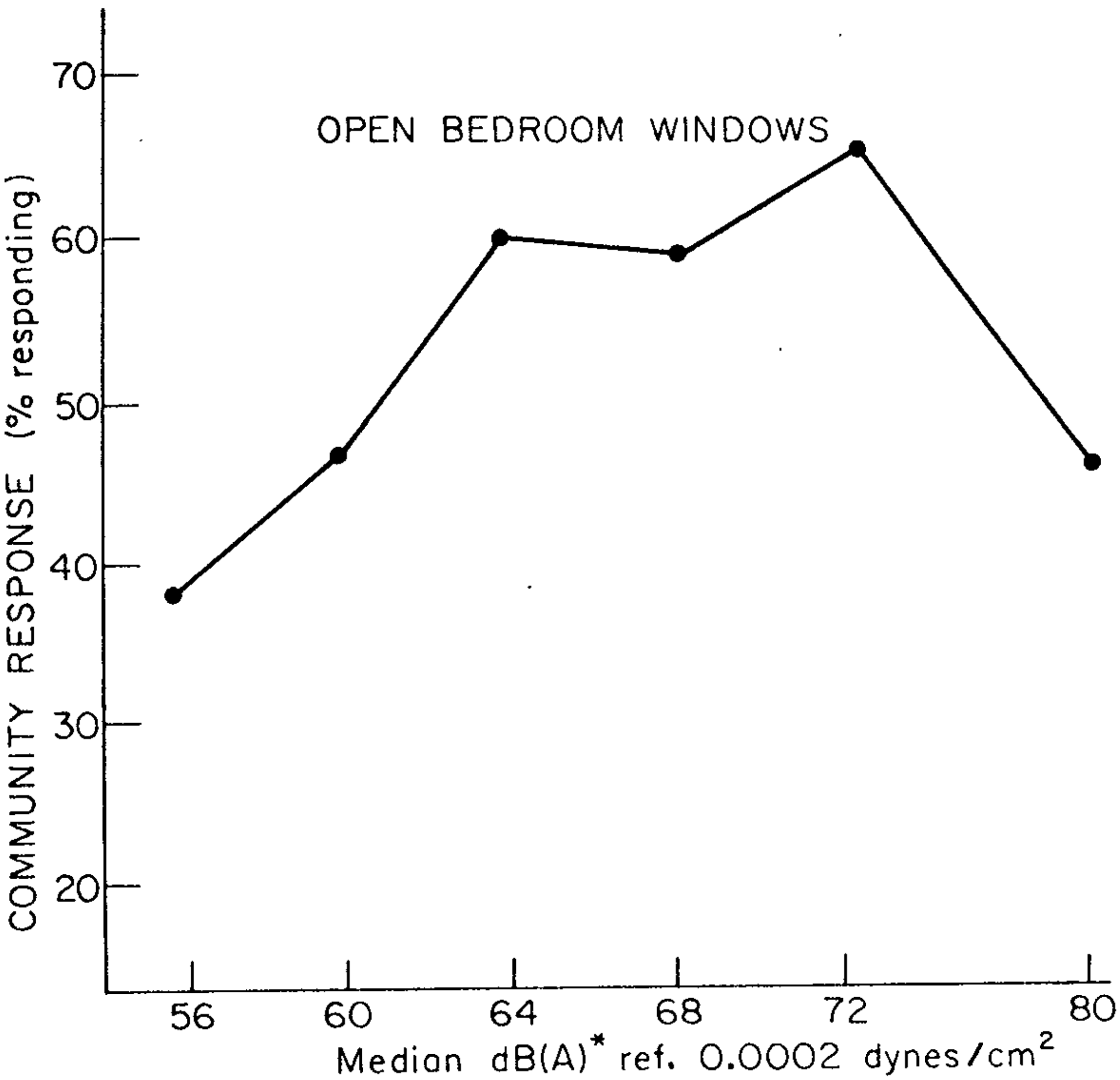


Figure 10. Relation Between Self-Rating Scale of Annoyance with Freeway Noise and Median Noise Level for All Survey Respondents Living Near and Adjacent to Freeways.



* Median dB(A) is used because of its superior correlation with community response. L_{10} is approxmately 5dB greater than median dB(A).

Figure 11. Relation Between Noise Level and Percent of People Who Often Leave Bedroom Windows Open at Night (at least once per week). Responses are based on summer Interviews only.

in the 58 to 62 dB(A) noise stratum are homes with their rear facing the freeway, and it follows that these are the homes where the greatest number of annoyed people live.

It is also possible to do a more detailed analysis of the locus of community response by determining the percent of annoyed people among all those who live in homes whose rear faces the freeway and secondly, among all those who live in homes whose front faces the freeway. Table 15 presents this detailed breakdown of the locus of community response for each type of home orientation. Among the rear oriented homes, the greatest number of annoyed people live in median noise levels of 58 to 62 dB(A), in confirmation of previous findings reported above; but in front and side-oriented homes, the greatest number of annoyed people live in the median noise levels of 66 to 70 dB(A).

Table 14. Distribution of Annoyed* People in Each Noise Stratum and in Total Sample.

Noise Stratum (Median dB(A))	Percentage of People in Each Stratum Who are Annoyed*	Percentage of People Living in each Noise Stratum	Percentage of Annoyed* People in the Total Sample
74+	66.7	12.3	8.2
70–74	57.4	8.4	4.8
66–70	50.6	15.9	8.0
62–66	53.8	13.9	7.4
58–62	42.1	29.2	12.3
54–58	20.6	12.1	2.4
Under 54	19.6	8.2	1.6

*A person is defined as annoyed if his or her individual score (based on spontaneous mention of subjective reactions against freeway noise) is above the average score for the entire sample.

Figure 14A. A Breakdown of Home Locations in Each Noise Stratum.

HOME LOCATION	NOISE STRATUM (Median dB(A)) Under 54	54–58	58–62	62–66	66–70	70–74	74+	Sample Size
Freeway Adjacent Homes (1st and 2nd rows)								
Rear Facing Freeway	6.5%	22.7%	52.1%	6.5%	9.2%	38.6%	25.3%	151
Front Facing Freeway	6.5%	18.2%	22.0%	48.1%	54.0%	43.2%	42.3%	184
Side Facing Freeway	17.5%	16.6%	9.2%	20.7%	35.6%	15.9%	5.6%	92
Near Freeway Homes (3rd row to one block)	69.5%	42.5%	16.7%	24.7%	1.2%	2.3%	26.8%	124
	100%	100%	100%	100%	100%	100%	100%	
SAMPLE SIZE	46	66	163	77	87	44	71	551

Table 15. Detailed Breakdown of the Percentage of Annoyed* People Within Each of the Home Orientations of Freeway-Adjacent Homes.

HOMES WITH REAR FACING FREEWAY

Noise Stratum (Median dB(A))	Percentage of People in Each Stratum Who are Annoyed*	Percentage of People Living in Each Noise Stratum	Percentage of Annoyed People in Rear-Face Homes
74+	77.8	11.9	9.3
70–74	64.7	11.3	7.3
66–70	25.0	5.3	1.3
62–66	60.0	3.3	1.9
58–62	44.7	56.3	25.1
54–58	20.0	9.9	2.0
Under 54	33.0	2.0	0.7

HOMES WITH FRONT FACING FREEWAY

Noise Stratum (Median dB(A))	Percentage of People in Each Stratum Who are Annoyed*	Percentage of People Living in Each Noise Stratum	Percentage of Annoyed* People in Front-Face Homes
74+	73.3	16.3	13.5
70–74	52.6	10.3	5.4
66–70	61.7	25.5	15.5
62–66	54.1	20.1	10.8
58–62	36.1	19.6	7.1
54–58	33.3	6.5	2.2
Under 54	33.3	1.6	5.3

HOMES WITH SIDE FACING FREEWAY

Noise Stratum (Median dB(A))	Percentage of People in Each Stratum Who are Annoyed*	Percentage of People Living in Each Noise Stratum	Percentage of Annoyed* People in Side-Face Homes
74+	25.0	4.3	1.1
70–74	42.9	7.6	3.3
66–70	38.7	33.7	13.0
62–66	50.0	17.4	8.7
58–62	40.0	16.3	6.5
54–58	27.3	12.0	3.3
Under 54	50.0	8.7	4.3

*A person is defined as annoyed if his or her individual score (based on spontaneous mention of subjective reactions against freeway noise) is above the average score for the entire sample.

The Relation of Community Response to Other Variables

Validity of the Measures of Community Response

As stated earlier in this paper, one cannot state that A causes B, or that noise causes community response solely on the basis of a correlation between the two factors. Two other criteria need to be met. Noise must occur prior to the response and the relation must hold true even when controlling the influence of variables which occur prior to both noise and the noise response. The first criteria is known to be true, but the second one requires testing. A partial correlation procedure is employed to determine the correlation between median noise level and the measures of community response when several possible antecedent conditions are controlled. If an antecedent condition causes or contributes to community response, the correlation between noise level and community reponse will be lowered when the effects of the antecedent condition are (statistically) controlled. In addition, if the correlation is lowered when the effects of the antecedent condition are controlled, the measure of community response is called into question as being of lesser importance than the antecedent condition.

Most of the variables which were measured and tested for their influence on community response did not significantly change the correlation between all measures of community response and the median noise level, and their influence can therefore be ruled out in connection with the measures of community response to noise. These variables include all demographic variables (age, sex, race, income, housing status, employment status), physical features (home orientation, rooms nearest freeway), exposure (time spent at home, years of freeway exposure), all measures of attitude to and awareness of freeways (including fear of crashes and consideration of highway officials), and involuntary/voluntary residence near freeways.

Table 16 contains a summary of those variables which *did* have an influence on community response. Neighborhood annoyance (annoyance with other features of the neighborhood) and General Irritability are variables which can be considered as possible *causes* of community response. However, it is noteworthy that all variables found in Table 16 may have occurred *prior* to a person's formation of a reaction to freeway noise. Contrast these variables in Table 16 to the variables of age, sex and race, for example, which have occurred

Table 16. Summary of Other Variables Which Influence Community Response to Freeway Noise.

	Correlation with Median dB(A)	Partial Correlation when Controlling For: Neighborhood Annoyance	General Irritation	Behavioral Effects
COMMUNITY RESPONSE				
Spontaneous Subjective	.26	.22	.24	.22
Spontaneous Behavioral	.12	.08	.09	—
Elicited Behavioral	.17	.09	.13	—
Elicited Subjective	.30	.24	.27	.25
Outdoor Behavior	.28	.26	.26	—

without a doubt before the occurrence of a community response to freeway noise.

Since there are no antecedent conditions which contribute to the measures of community response used in this study, it may be assumed that the measures are valid indictors of community response.

The Influence of Activity Interruption

It has often been stated that a person becomes aware of and reacts against freeway noise when his or her daily activities are interrupted. The partial correlation procedure affords an opportunity to measure the influence of activity interruption on subjective reactions to noise. The Spontaneous and Elicited Behavorial Measures were combined and statistically controlled, when correlating the Subjective Measures with median noise level in dB(A). The results are shown in Table 16. The correlation is reduced approximately 15 percent and the correlation between noise level and Elicited Subjective effects is reduced about 17 percent. Behavioral interruptions are contributing to subjective community responses, but not enough to warrant the assumption that they are a sufficient condition for a Subjective reaction to freeway noise.

The "Disposition" for Community Response

Certain variables may influence one's reactions to noise regardless of the noise level to which one is exposed. If a variable influences one's reaction to the freeway noise, the correlation between community response measures and that variable will not be changed when the effects of noise exposure are eliminated. A partial correlation procedure was employed with the median noise level in dB(A) held constant. Each of the measures of community response was correlated with several possible variables and then compared to the partial correlation when noise level was held constant.

Most of the variables had lower correlations with the measures of community response when noise exposure was held constant. This means that their contribution to the community response is less influential than the contribution of the noise exposure. Those few variables which influence community response (*i.e.*, whose partial correlation coefficients were not significantly lower or were even higher that their original correlations with community response scores), are summarized in Table 17.

Table 17. Summary of Variables which Influence Measures of Community Response Independent of the Noise Level.

	Pearson Correlation with Variable/Partial Correlation with Variable When Noise is Held Constant:				
	Awareness	Attitude	Fear	%Black	Income
COMMUNITY RESPONSE					
Spontaneous Subjective	.14/.15	.28/.28	.09/.09	-.17/-.16	.08/.11
Spontaneous Behavioral	-.01/-.01	.05/.05	.11/.10	-.03/-.02	.01/.03
Elicited Behavioral	.18/.18	.26/.25	.29/.29	-.10/-.10	.01/.03
Elicited Subjective	.19/.20	.31/.30	.21/.21	-.16/-.16	.01/.05
Outdoor Behavior	-.00/-.02	.01/-.00	.13/.12	-.01/-.00	-.03/-.00

Awareness of freeway noise and attitude about freeways influence those community reactions which are Subjective or Elicited. The percentage of black people in a neighborhood is inversely related to the Subjective Effects. In other words, black people are not likely to say they have a subjective reaction against freeway noise even if they live in the highest noise levels. And finally, a fear of vehicle accidents on one's property is related to the Elicited Effects; or, in other words, a person will admit to being affected or disturbed in various ways by freeway noise if that person also admits to a fear of accidents, regardless of the noise level to which one is exposed.

Predictors of Individual Response

The partial correlation precedures have demonstrated that there will be a community response to existing freeway noise which depends, to some extent, upon the respondent's level of irritation and annoyance with other neighborhood features, and will be influenced by fear of crashes, attitude to freeways, awareness of the noise and percentage of black people in the neighborhood. A predictive equation can be generated from these variables to determine the relative weight or importance of each variable in predicting a measure of community response.

Multiple regression equations of the dummy variable type were computed for prediction of each of the five types of community response. The independent (predictor) variables also included the noise measure which is the optimum predictor of community response for each measure (see Table 11); and all demographic and physical characteristics which did not appear to have a significant effect in the partial correlations procedures. The latter were included in the event that their influence is felt through their interaction with other variables.

The multiple correlation between each measure of community reponse and all variables in the regression equation ranged from a low of .36 (Spontaneous Behavioral Effects) to a high of .56 (Elicited Subjective Effects). Please see Appendix D for a full account of each variable's contribution to the regression equations.

Each Community Response can be predicted by a unique combination of predictor variables. Table 18 summarizes the most important of these variables. A variable is arbitrarily defined as important if it contributes to at least 1.5 percent of the known variance.

Table 18. Tabulation of Those Variables Which Contribute to at Least 1.5% of the Known Variance to the Regression Equations.

Variable	Percent of Variance Contributed to Regression Equation for the Given Community Response				
	Spontaneous Subjective	Spontaneous Behavior	Elicited Subjective	Elicited Behavior	Outdoor Behavior
Noise Pollution Level	7.7%	1.6%			
Median Noise Level			9.2%	3.1%	
90 Percentile Noise Level					8.0%
Awareness of Freeway Noise	1.8%		3.0%	2.2%	
Disbelief of Advantage to Live Near Freeways	1.5%		1.6%	1.6%	
Percent of Caucasians Living in Neighborhood	1.5%		1.7%		
Annoyance with Other Neighborhood Features		2.1%	8.1%	9.8%	
General Attitude Toward Freeways		1.6%		1.9%	
Communication Interference		1.6%			
Fear of Freeway Accident on One's Property			4.0%	8.5%	
Location of Bedrooms Relative to Freeway					3.1%

It is interesting to note that all community responses which are elicited from the respondents, whether they refer to activity interruptions or subjective disturbance, have five predictive variables in common: median noise level, fear of accidents, annoyance with neighborhood, awareness of noise, and a belief that living near freeways is not an advantage. As these responses are all elicited or "prodded" from a respondent, they are probably not an indication of one's fervent convictions, but of statements to which one will agree, once they are brought to one's attention.

The subjective reactions to freeway noise have three predictive variables in common: awareness of noise, percentage of Caucasians, and disavowal of advantage of freeway proximity. These variables will influence a person's response to freeway noise independently of the type or frequency of activity disturbance.

Comparison with Nonfreeway Neighborhoods

The fact that the freeway noise disturbs or disrupts the occupants of homes near freeways does not imply that freeway noise is the only means by which people may be disturbed. Indeed, the average neighborhood is beset with other features which may be as disruptive or disturbing as freeway noise. The responses of the Freeway Sample are compared with a matched sample in Nonfreeway areas (for definitions of samples, see "Sample Characteristics"). One hundred thirty-four respondents from the Freeway Homes are compared with 134 respondents from homes in neighborhoods which were similar in every way to the freeway homes, except for the distance from the freeway.

These two samples are compared on all questionnaire items which do not directly mention freeway noise. Simple scales were computed by summing those questionnaire items which met the above criterion of unrelatedness to freeway noise. These scales are similar to the Spontaneous Factor scales, but not to the Elicited Response scales which all involved direct questioning about freeway noise.

The mean scores on the new scales for the Freeway and Nonfreeway Samples were tested for significant differences by means of an analysis of variance The results are displayed in Table 19. Both Subjective Disturbances and Behavioral Disturbances were significantly greater for the Freeway Sample than for the Nonfreeway Sample.

The Subjective Disturbance scale consisted of items about desires to move, to complain, or to live in quiet, remote places. Figure 12 presents a bar graph of some of the items in this scale. Nine and eight-tenths percent of the Nonfreeway Sample had complaints about their neighborhood for which they had gone to the authorities, but 25.2 percent of the Freeway Sample had complained to the authorities about their neighborhoods (not necessarily about freeway noise) The corresponding figures for desiring to move out of their neighborhood are 38.8 for the Nonfreeway Sample and 45 7 for the Freeway Sample.

The Behavioral Disturbances scale consisted mostly of items about sleep difficulties. Without reference to a particular noxious element, 24 6 percent of respondents in the Freeway Sample reported difficulties in falling asleep in contrast to 14.9 percent in the Nonfreeway Sample (see Figure 12) Fifty-five and two-tenths percent of the Freeway Sample reported problems in remaining asleep and 50 percent of the Nonfreeway Sample reported a similar problem.

Table 19. Mean Scale Scores and Test of Significance Between Scores for Freeway and Nonfreeway Samples.

	Mean Scale Score		Analysis of Variance	
	Freeway Sample	Nonfreeway Sample	F-test	sign.*
Scale				
Subjective Disturbance	9.39	8.38	13.09	.01
Behavioral Disturbance	3.85	3.06	42.74	.01
Outdoor Behavior	5.77	5.79	1.89	n.s.
Attitude to Freeways	3.93	3.76	2.13	n.s.

*Probability that differences in scale scores occurred by chance alone (df = 1,266).

N.S. is assumed when significance > .10.

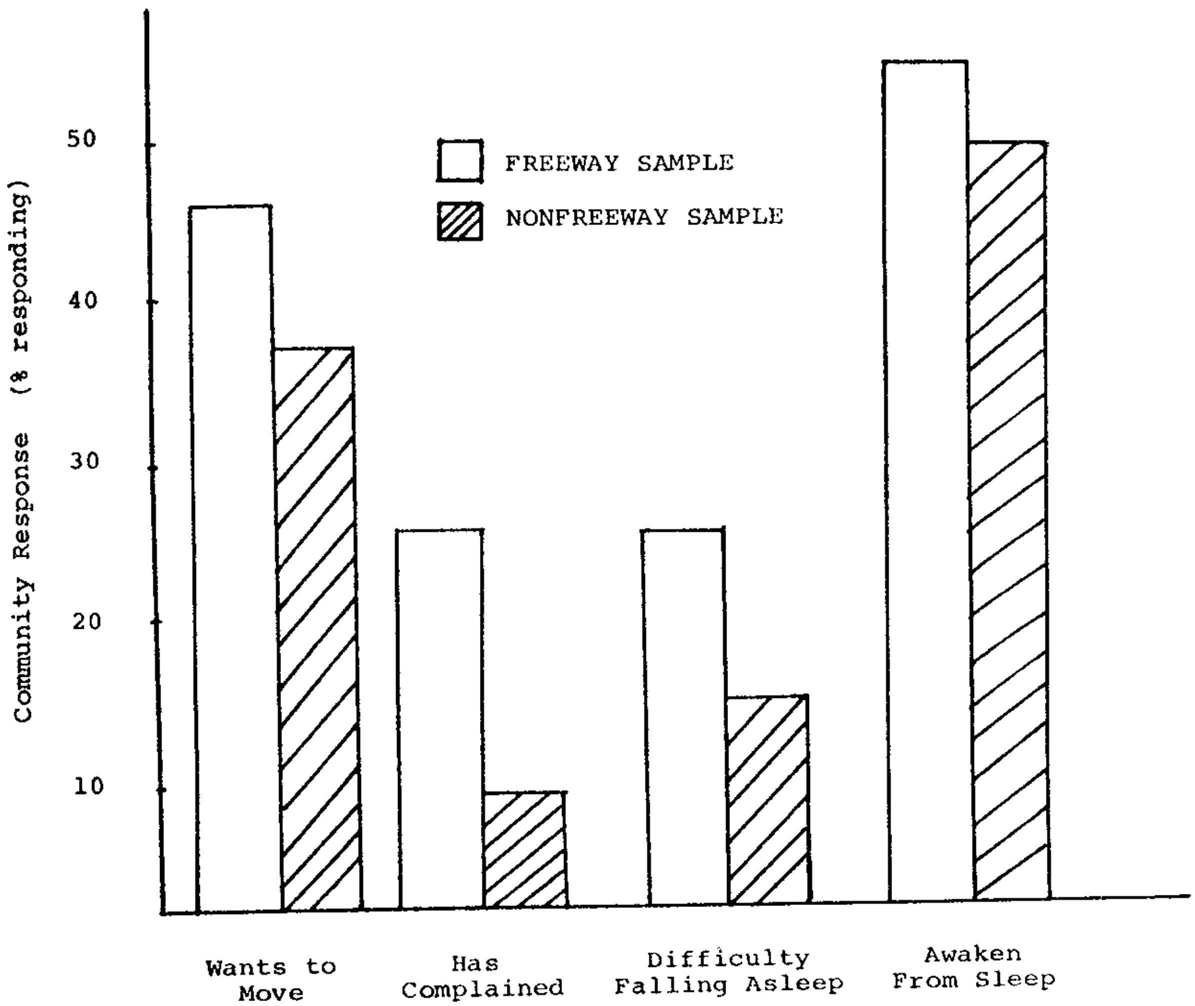


Figure 12. Community Response, Without Reference to Freeway Noise, in Freeway and Nearby Freeway Neighborhoods.

The Subjective and Behavioral Disturbances must be interpreted with caution because of rival explanations. For example, (1) the neighborhoods near freeways may have other problems or features that cause disturbances, and (2) people who live in the Freeway Sample may have more problems of their own which lead to sleep disturbances. The two samples were not matched by personality characteristics, so the second interpretation is quite possible. However, the neighborhood appearance and the demographic characteristics of the two samples were matched in such a way that the likelihood of the first interpretation is minimized. The subjective complaints or signs of discontent seem to be related to freeways, although perhaps in indirect ways, such as the lowering of property values.

The Outdoor Behavior scale was computed from responses in summer only and consists of the same items as the factored Outdoor Behavior Measure of Community Response closure of doors and windows and use of outdoor property. There were no significant differences between the Freeway and Nonfreeway Samples on this scale; however, the individual items within this scale all exhibited a trend in a direction opposite from the one expected More people in the Nonfreeway Sample reported that they kept their doors and windows shut in daytime and at night, and that they used their outdoor property very little. The small size of this sample (N = 44) for this scale mitigates against drawing any firm conclusion about this trend.

There were no signficant differences between the Freeway and Nonfreeway samples on their general attitude toward freeways. When the items which constitute this scale were analyzed individually by an X^2 procedure (see Appendix D), the item about the consideration of highway planners was found to be significantly different for the two samples. The respondents in the Freeway Sample were more inclined that those in the Nonfreeway Sample to state that freeway planners had less consideration for the needs of citizens.

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APPENDIX A
MEASUREMENT RANGE AND CALIBRATION OF THE INSTRUMENT SETUP

A schematic diagram of the measurement setup is given in Figure 2. A description of the features and limitations of the equipment used is given below in order to gain a better overview of the instruments, to understand the interfacing and calibration procedure and to properly interpret the field measurements.

The B & K 2209 Precision Sound Level Meter is employed to measure the noise level at a specified location. The ac voltage output of the 2209 is proportional to its meter deflection with a maximum voltage output corresponding to a full scale meter deflection of +10 dB. That means, for example, the ac voltage output is 20 dB lower than the maximum output voltage when the meter deflection is -10 dB. The dynamic range of the ac voltage output of the 2209 is about 50 dB; that means the ac voltage output of the 2209 is linearly proportional to its meter deflection in the meter scale range from about -40 dB to +10 dB. For meter deflections of less than -40 dB or more than +10 dB, the ac voltage output is the same as that obtained for a meter scale deflection of -40 dB or +10 dB respectively.

As shown in Figure 2, the ac voltage output of the 2209 is fed into the input of the B & K 166/SJ45 Environmental Noise Classifier and thus acts as its noise source.

In order to calibrate the setup, the B & K 4220 piston calibrator was employed which puts out an SPL of 124 dB at 250 Hz. The meter deflection of the 166/SJ45 is offset by 29 dB above its base level setting. Therefore, calibrating the setup implies a zero meter reading of the 166/SJ45 when its base level is set at 95 dB (95 + 29 = 124 dB). While the 4220 piston calibrator was used for the setup calibration, the B & K 2209 was set at 120 dB, and we adjusted the gain of the 2209 to show 120 dB. Thus, a zero meter scale deflection of the 2209 is to be interpreted as 124 dB by the 166/SJ45. Selection among the 85, 90, 95 or 100 dB base level settings of the 166/SJ45 can be used to shift the count into the desired window of the 166/SJ45 with the 2209 set at 120 dB.

Now suppose that during field measurements, the 2209 was set at 70 dB and not at 120 dB as during calibration. An SPL of 74 dB will then cause the 2209 meter scale to show 0 dB. The corresponding ac voltage output of the 2209 will be interpreted as 124 dB by the

166/SJ45. The dynamic range of the 2209, when it is set at 70 dB, is from about 34 dB to 84 dB, which will be interpreted by the 166/SJ45 as an SPL range from 84 dB to 134 dB. Hence, the setting of the 2209 during field measurements has to be recorded in order to determine the actual SPL being measured.

Table A-1 gives the actual SPL being measured, based on a variety of settings of the 2209 and the 166/SJ45. As can be seen from this table, a special feature of this setup is an extension of the dynamic range of the 166/SJ45 down to 15 dB which is the limit set by the sensitivity of the B & K 4145 condenser microphone.

FIGURE A-1
The range of the Environmental Noise Classifier is divided into 11 windows of alternate 2 and 3 dB(A) widths. The 12th window measures all levels greater than the 11th window.

The base level, X, can be adjusted according to need over a range as shown in TABLE A-1.

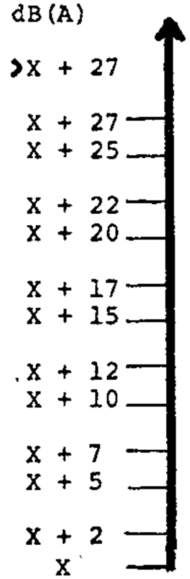

TABLE A-1.
With the setup shown in FIGURE 2 , the dynamic range of the Environmental Noise Classifier can be extended by extending the range of the base level, X, from 15 to 110 dB(A), as shown in the last column.

Sound Level Meter 2209			Environmental Noise Classifier 166/SJ45	
	Setting of Instrument Base Level Selector, dB	Actual Dynamic Range, dB	Setting of Instrument Base Level Selector, dB(A)	Actual Base Level, X dB(A)
Highest possible setting	130	94-144	100	110
			95	105
			90	100
			85	95
Calibration Setting	120	84-134	100	100
			95	95
			90	90
			85	85
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-		
Most Common Field Setting	70	34-84	100	50
			95	45
			90	40
			85	35
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-	-	-
	-	-		
Lowest Possible Setting	50	14-54	100	30
			95	25
			90	20
			85	15

APPENDIX B
DETAILS OF SURVEY OPERATING PROCEDURE

All the maps are drawn on xerographed copies of city zonal maps which correspond to the areas covered by the Department of Transportation aerial photographs. Each map has the houses to be interviewed clearly marked by color coding to direct the interviewers to the proper neighborhood. In addition, the freeways are marked for easier identification and a nearby offramp indicated to direct the interviewer to the areas and hopefully to eliminate wasted time in finding the location. Occasionally additional instructions were added to the back of the map.

The high noise areas are those neighborhoods directly bordering freeways, and are indicated in blue ink. The houses were chosen for interviewing because of their immediate proximity to the freeway, often no more than 20 to 30 yards.

The maps for high noise areas are numbered sequentially and the number of houses on the map were counted as accurately as possible and indicated in the upper righthand corner. An estimated eight houses could be canvassed per hour; the number of houses per map was divided by eight to obtain an approximation of time to finish that particular map. We could then assign hours per person per week, allowing sufficient time for driving.

The medium noise areas were chosen by their proximity to the high noise areas and generally were one-half to one block further "inland" from the freeway. They are indicated by pink lines and arrows on the same maps as the high noise areas and cover approximately the same number of houses as covered in the "high noise" survey. The houses were chosen by reference to the aerial photographs and chosen only after checking for best alternative selections. These areas were then marked on the corresponding zonal map and notes were added to avoid overlapping interviews in the somewhat close lines between higher and lower noise areas.

The control group noise areas were then chosen, using the criteria outlined in the main body of the report. Since we had no aerial photos to use in these outlying areas, it was strictly "best judgment" selection and as a result, our interviewers were given the freedom to go to another area should the indicated area prove to be inaccessible or problematic. The areas were indicated in green on the same zonal maps used in the above survey.

Interviewers were encouraged to comment on the areas they confronted and the diary comments usually gave a little more insight into the type of neighborhood being interviewed.

We identified what we thought were "dangerous areas" and held them until the end so we could work in teams. (See below about black areas.)

Interviewers were asked to match the number of successful interviews completed in the high noise areas when they interviewed in the other two areas, so we would have a comparable sample. The insure this, completed diaries from the high noise survey area were attached to the maps of the medium and low areas so workers would know how many interviews to get and would also read diary comments made about the neighborhood by the first interviewer.

The returned interviews and diaries were tabulated and totaled for a weekly summary of activity. We compiled refusal and completion rates for each interviewer and for each day of the week as well as overall averages, in order to determine which was the best day for completing interviews, which interviewer had a high or low refusal rate, and what percentage of the homes assigned were actually interviewed. This information was valuable for counseling of interviewers and for determining the best time to attempt interviews.

In areas of high concentrations of blacks, our white interviewers had high refusal rates. We hired a black person to interview these areas and the refusal rate dropped to zero. Hence, future maps were sorted by known black areas and held for coverage by our black worker

Interviewers were asked to mark the exact locations they had surveyed on the zonal maps, and to make corrections on those maps when necessary, the completed maps were then given to the noise measurers with the assurance that they would quickly locate the appropriate sites.

When the interviewers returned their maps, they were ready for assignment to the noise measurers. A little trick we found for determining to what area to send our noise measurers was to group all the maps by immediate location in one circle (out of a long list of maps), then shade the map numbers in one color to indicate they were ready for the noise measurements. When all maps in that particular circle were shaded we would make them available This ensured that once the area was covered, we would not have to return to that area again, thus saving time and travel money. In addition, the maps which were not ready were coded with another color to indicate what was causing the delay. In this way, we could expedite a particular map if it was holding up a large segment of maps.

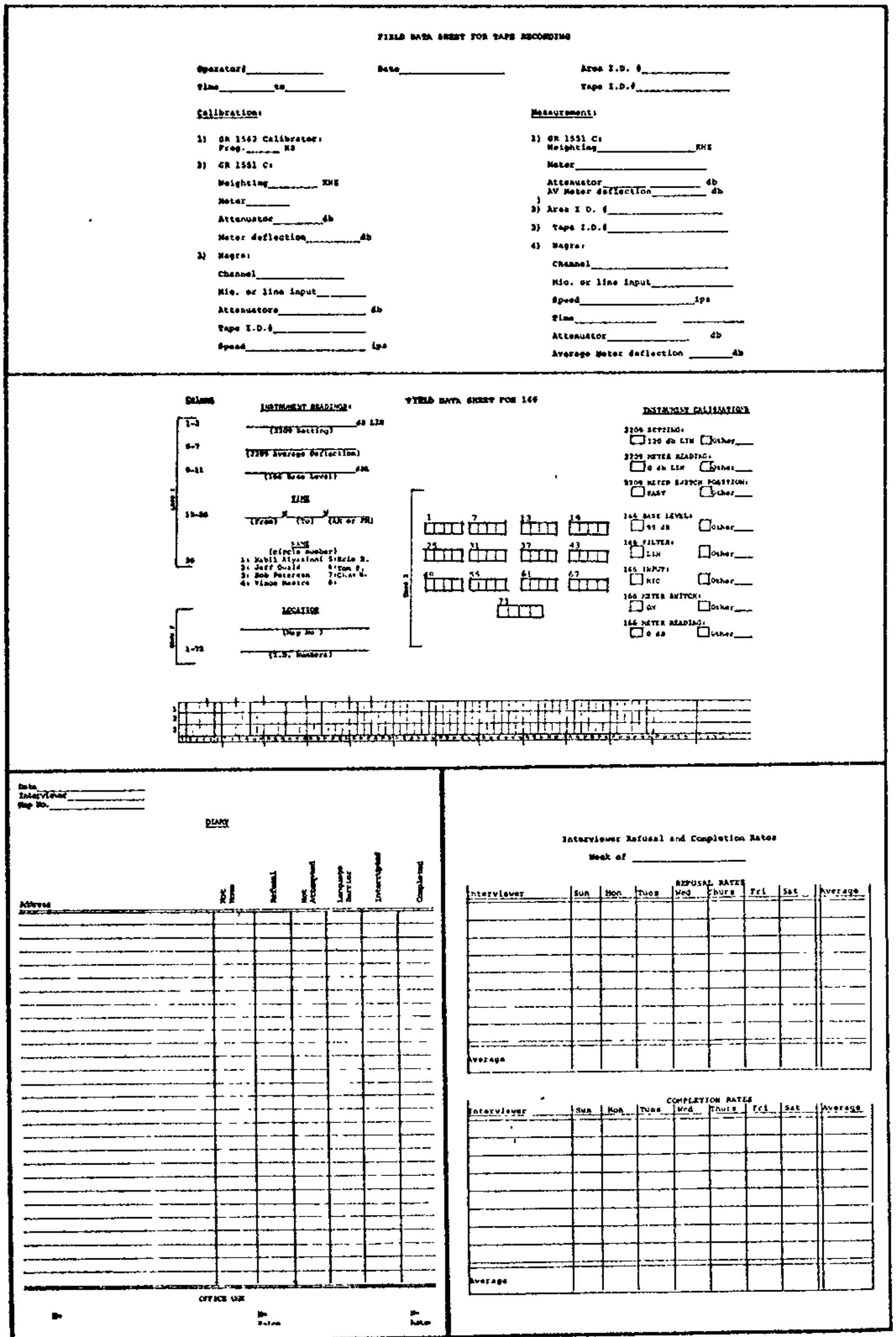

Figure B-1. Survey Forms, Including Field Operator Data Sheets, Interviewer "Diary," and Office Record of Interviewers.

APPENDIX C
FACTOR SCALE CONSTRUCTION

The items were orthogonally rotated to a Kaisar Varimax Criterion by the method of principal factors with maximum element of correlation matrix in the diagonals. Ten factors were extracted; the factor loadings of the entire matrix appear in Table C-4. Table C-1 presents a comparison of the obtained factors and the originally expected scales. The items are listed by the name of the scale for which they were originally devised, and one can see at a glance that the factored scales correspond closely to the expected (original) scales.

Factor I, accounting for 25.2 percent of total variance (among ten extracted factors), contains the important Elicited Items. The scale was divided into Elicited Subjective and Elicited Behavioral Effects according to the original plan. Factor II, accounting for 15.7 percent of the total variance, was retained as an index of Spontaneous Subjective Effects. Factor III is an index of those Spontaneous Behavioral Effects which relate to the opening of doors or windows and the use of outdoor property. As it accounts for nearly ten percent of the total variance, this factor scale is added to the original scheme as a subset of Elicited Behavioral Effects and is entitled "Outdoor Behavioral Effects." The only scale needed for completion of the original scheme, Spontaneous Behavioral Effects, was not clearly defined by any factor before Factor X, which only accounted for 5.5 percent of the variance. It was decided to combine Factor X with Factor VII and together they account for 12.3 percent of the variance. Factor IX formed the basis for a measure of attitude to freeways (fear of accidents did not cluster on this factor as expected); and a closer examination of Factor VIII revealed items reflecting irritability. Factors IV, V and VI were not clearly related to the substructure which was originally postulated and will not be scrutinized because of the liberties which have already been taken with the use of factor analysis.

Factor score coefficients were indeterminate for this data so composite scales could not be formed by regression weights with standardized scores. However, the factor weights were used as estimates in weighting each Factor Scale.

Since much of the data is ordinal rather than interval, the factor scales are not composed from the standardized score, but from variables divided by the number of categories or possible alternative answers for that variable. The equally weighted scores which result from that simple transformation are then weighted by the factor loadings. Table C-2 presents a summary of the correlation coefficients between the factored scales, the original theoretical scales, and the simple summations of the factored scales without the factor weightings. The unweighted factor scales have sufficiently high correlations with the weighted factor scales to be used in place of the latter, but the computer simplifies the computation and the latter were retained.

Table C-3 presents the intercorrelations between the Factor Scales. The Elicited Scales, with a correlation of .531, seem to be closely associated, but Spontaneous Scales have a sufficiently low correlation to warrant the assumption that behavioral interruptions produce a different kind of community response than produced by subjective reactions to freeway noise.

I	II	III	IV	V
EB .35	SS .50	SB .54	ES .60	ES -.54
EB .34	SS .41	SB .43	ES .46	income .34
EB .28	SS .35	SB .40	ES .38	ES .31
EB .26	SS .34	SB .33	ES .38	SB -.29
EB .25		SB .19		
EB .22				
ES .28				
ES .25				
ES .23				

EB=Elicited Behavioral SB=Spontaneous Behavioral
ES=Elicited Subjective SS=Spontaneous Subjective

VI	VII	VIII	IX	X
ES .54	SB .69	ES .40	att. .36	SB .45
ES .45	SB .66	ES .36	ES .30	SB .42
ES-.31		SB .32	att. .30	SB .39
ES .24		SB .30	att. .24	SB .38
			ES .26	SB .36
				SB .27

Table C-1. Comparison of expected scales with factored scales. Items within factors are named by the scale for which they were originally devised. Only factor loadings $>$ .20 are reported.

Table C-2. Pearson Correlation Coefficients Between Factor-Weighted Scales, Unweighted Factor Scales and Original Theoretical Scales.

	Unweighted Factor Scale	Original Theoretical Scale
F WEIGHTED SCALE		
Elicited Subjective	.96	.66
Spontaneous Subjective	.99	.69
Elicited Behavioral	.99	.62
Spontaneous Behavioral	.97	.79

Table C-3. Pearson Correlations Between Measures of Community Response (formed from factor scales).

	INTERCORRELATIONS			
	Spontaneous Behavioral	Spontaneous Subjective	Elicited Subjective	Elicited Behavioral
Spontaneous Behavioral	1.00			
Spontaneous Subjective	.214	1.000		
Elicited Subjective	.330	.446	1.000	
Elicited Behavioral	.416	.330	.531	1.000

Factor Scale Composition and Factor Weights

Spontaneous Behavioral = (Awaken from Sleep/2x.69) + (Mention Conversation/2x.45) + (Mention Relax/2x.42) + (Mention TV/2x.39) + (Mention Sleep/2x.38) + (Mention Concentration/2x.36) + (Mention Other/2x.27)

Spontaneous Subjective = (Freeway Frequency/4x.50) + (Magic Wish/2x.41) + (Dissatisfied/2x.34) + (Move from Freeway Noise/2x.35)

Elicited Subjective = (Rate Freeway Noise/5x.23) + (Most Annoying Feature/2x.28) + (Adapt to Noise/2x.25)

Elicited Behavioral = (Checked Sleep/2x.35) + (Checked Relax/2x.34) + (Checked Conversation/2x.28) + (Checked TV/2x.26) + (Checked Reading/2x.25) + (Difficulty Falling Asleep/2x.22)

Outdoor Behavioral = (Use Outdoor Property/4x.33) + (Bedroom Windows at Night/4x.43) + (Doors, Windows Open/4x.40) + (Observed Doors, Windows Open/3x.19) + (Behavior Frequency/10x.54)

General Irritability = (Rate Noise/5x.40) + (Neighborhood Annoyance/8x.36) + (Noisy Neighbors/2x.32) + (Neighbors Use Mask Sounds/2x.30)

Attitude to Freeways = (Importance/3x.36) + (Planners' Consideration/3x.30) + (Advantage Living Near/3x.24) + (Aware of Freeway Noise/3x.30)

APPENDIX D: QUESTIONNAIRE AND ITEM ANALYSIS

Date __________
Interviewer __________
Map No. __________

OFFICE USE ONLY
_____ *OKed*
_____ *Tally*
_____ *Keypunch*
_____ *Misc.*

NEIGHBORHOOD ECOLOGY SURVEY

I am from the University of Southern California. We are concerned about the quality of neighborhoods in Los Angeles and we are trying to gather information on neighborhood ecology. I would like to ask you a few questions or make an appointment when you have time. (*If they agree, begin Question No. 1. If they refuse or look reluctant, say: We are especially interested in interviewing people whose initial response is "no"; otherwise we would only be interviewing yes-men, do-gooders, and lonely people.*) (Voice raised: Yes 2; No -1.)

1. How long have you lived in this house?
2. Do you spend most of your time in the home or do you work most or part of the time? Home *1*; Work Part Time *2*, Work Full Time *3*.
3. Before you moved here, where did you live?
4. Was it a similar kind of neighborhood? *Yes; No.*
   Was it about the same distance from schools? *Yes; No.*
   Was it about the same distance from freeways? *Yes, Closer, Further*.
5. Have you ever thought about moving out of this neighborhood? No *1*; Futile *2*, Yes *2*. (If yes) For what reason did you think about moving? *Freeway reason 2; Nonfreeway reason 1.*
   Any other reasons?
6. Have you ever or are you thinking about complaining to the authorities about your neighborhood? No *1*; Futile *2*, Yes *3*. If yes, what was or is the reason for your complaint? *Freeway reason 2, Nonfreeway reason 1.* Any other complaints?
7. What one thing in your neighborhood are you most dissatisfied with? *Freeway (noise)--2, Nonfreeway--1.* Any other complaints?
8. (*Read slowly*) Imagine that you have one magic wish and you can have anything you want. What one thing in your neighborhood would you change with this magic? *Freeway (noise) 2; Nonfreeway -1.* Anything else?
9. Do you own *1*, or rent *2* your home?

10. Do your neighbors play their radio, TV or stereo too loudly? *Yes 2; No 1.*
11. Do you ever get complaints on your radio, TV or stereo? *Yes 2, No 1.*
12. Do you have noisy neighbors? *No- 1; Yes--2.*
13. When do you leave your doors or windows open? (*You may check more than one.*) Never *4*; Warm days *3**; Warm Evenings *3**; Other Days *3**, All the Time or Normally All the Time *1*. (**2 if more than one.)*
14. How often would you say that you use your outdoor property for enjoyment such as picnics, lawn games, or just sitting? Rarely *4*; 1-3 times a month *3*; Once a week *2*; More than once a week *1*.
15. Have you ever had trouble falling asleep at night in this house? No *1*, Yes *2*. (If yes) When? *Freeway noise 2; Nonfreeway 1*, and how often? Any other times?
16. How often do you leave your bedroom window open at night? Rarely *4*; 1-3 times a month *3*; Once a week *2*; More than once a week *1*.
17. Have you ever been awakened from your sleep by loud noises? *No; Yes.* (If yes) What noises? *Freeway noise 2, Nonfreeway 1*, and how often? Any other times?
18. If you could move, where would you move to? *Nonfreeway (remote) 3, Possible freeway--2, Same area 1.*
19. I would like you to classify certain things in your neighborhood as pleasing, of no concern, a little annoying, or very annoying. What do you like the most about your neighborhood? (*Write on line (a) below)* We'll call that pleasing. You have already said that (*see answers to No. 5 through 8 and write on line (b) below)* was very annoying to you. So keeping these extremes in mind, would you classify type of neighbors as pleasing, of no concern, a little annoying, or very annoying? (*Read the following items in a similar way.*)

	Pleasing (1)	No Concern (2)	Little Annoy. (3)	Mod. Annoy. (4)	Very Annoy. (5)
(a) ______	X				
(b) ______					X
Type of neighbors					
Dirt/Smog					
Traffic Safety					
Freeway Noise					
Schools					
Loud Noises					

20. You (did) (did not) mention loud noises as annoying (see above). Are there any other loud noises in your neighborhood? *No; Yes 1 in Q.19D.* (If yes) What are they? Any other loud noises?

21. Has smog ever interfered with your: (*Check if yes*)
    Resting *1 or 0*
    Breathing *1 or 0*
    Concentration *1 or 0*

For those of you who live near freeways, we have a few additional questions.

22. How does freeway noise interfere with your daily activities? *Mention TV (1 or 0), Conversation (1 or 0), Sleeping (1 or 0), Relaxing (1 or 0), Reading (1 or 0), Other (1 or 0).*

23. Has freeway noise EVER interfered with your: (*Check if yes*)
    TV listening *1 or 0*
    Conversation *1 or 0*
    Sleeping *1 or 0*
    Relaxing *1 or 0*
    Reading *1 or 0*

24. (*If not mentioned in No. 19 or No 20*) What specifically is the most annoying feature of the freeway? *Noise 1; Truck Noise 2; Accidents 3; Dirt 4, Appearance 5; Other 6; Workers 7; Crowding 8; Driving Conditions 9.*

25. Are you more or less aware of the freeway now than you were at first? *More 2, Less 1; Same 1.*

26. Do you think that you've gotten used to freeway noise? *No 2; Yes 1.* (If yes) How long did this take?

27. When is freeway noise the worst?

28. Are you not afraid *1*
    slightly afraid or *2*
    very afraid *3*
    of freeway accidents which may harm your property here or your family?

29. Do you believe that freeways are
    not important or necessary *3*
    slightly important and necessary or *2*
    very important and necessary *1*

30. Do you believe that living near a freeway is
    not an advantage *3*

a slight advantage *2*

a great advantage *1*

31. How much consideration do you believe that freeway planners give for the concern and safety of the citizens?

    a great deal of consideration *1*

    a slight amount of consideration *2*

    little or no consideration *3*

These are all my questions. We would like to classify our answers by different categories, so there are a few personal questions I would like to ask. (*Show flashcards*) Age category _____ ; Income category _____ ; What is your telephone number (listed, unlisted) And your address is?

FOR THE INTERVIEWER

Time _____ ? Distance: Doorway *1*; I m. *2*; Other *3*

Sex of respondent: Male *1 or 0;* Female *1 or 0.*

Race. caucasian *1 or 0*; black *1 or 0*; Spanish-American *1 or 0*, Other *1 or 0*

Door of house: Facing freeway *1 or 0*; facing away from freeway *1 or 0*; side facing freeway *1 or 0*.

Rooms facing freeway: bedroom *1 or 0*; living room *1 or 0*; kitchen *1 or 0*; other or unknown *1 or 0.*

Open in interview room were Door *2**, Window(s) *2**, Neither *3*. (**1 if both*)

Household Sounds. When you entered the household, what type of household sounds did you hear?

1 or 0. Respondent had TV on

1 or 0. Respondent had music playing.

1 or 0. Respondent had children in the house.

1 or 0. Respondent had other type of sound. If so what type;

AMENDED SECOND PAGE FOR NONFREEWAY AREAS

20. You (did) (did not) mention loud noises as annoying (*see above*). Are there any other loud noises in your neighborhood? *No; Yes.* (If Yes) What are they?
    Any other loud noises?
21. Has smog ever interfered with your: (*Check if yes*)
    Breathing
    Resting
    Concentration
    For those of you who do not happen to live near freeways, we have a few more questions: (We will compare your responses to those who do live near freeways.)
22. N/A
23. N/A
24. What specifically is the most annoying feature of freeways?
25. N/A
26. N/A
27. N/A
28. N/A
29. Do you believe that freeways are
    not important or necessary
    slightly important and necessary or
    very important and necessary
30. Do you believe that living near a freeway would be
    not an advantage
    a slight advantage or
    a great advantage
31. How much consideration do you believe that freeway planners give for the concern and safety of the citizens?
    a great deal of consideration
    a slight amount of consideration
    little or no consideration

These are all my questions. We would like to classify our answers by different categories, so there are a few personal questions I would like to ask. (*Show flashcards*) Age category ___, Income Category ___, What is your telephone number (listed, unlisted), And your address?

(*Memorize*): Thank you very much for your cooperation. We will be writing about these results for a report to the State of California, we are particularly interested in making recommendations about the inconvenience caused by freeways.

Attitude

1 Interviewee was enthusiastic about being interviewed and/or made many attempts to make the interviewer comfortable.

2 Respondent was pleasant throughout entire interview.

3 Respondent was only pleasant for part of the interview but was never really unpleasant.

4 Respondent was very irritable throughout entire interview.

Unguarded Response

1 Disagreement: freeways are not a problem.

2 No response.

3 Agreement without elaboration.

4 Agreement with elaboration about sleep *1 or 0.*
TV *1 or 0.*
Safety *1 or 0.*
Concentration *1 or 0.*
Conversation *1 or 0.*
Other *1 or 0.*

3 m. (*Circle if heard at distance of 3 m.*)

2 1

Inside (*Circle if willing to have inside measures*)

2 1

English Spanish translation

ADVANTAGE: *ventaja, beneficio*
ANNOYANCE: *molesta*
AWAKENED: *despertado*
DISSATISFIED: *descontentado; desagradado*
INTERFERE: *imponerse; impedir*

MAGIC: *bruja*
NEIGHBORHOOD: *vecindad; vecindario*

Neighborhood Annoyance: Number of 3, 4, and 5 in Question 19.
Freeway Frequency: Number of times freeway mentioned in Question 5 through 8.
Behavior Frequency: Number of times interference mentioned in Question 10 through 17

Table D-1. Summary of X^2 Test of Association Between the Possible Responses for Each Item and the Median Noise Levels.

	X^2	df	sign.*
Spontaneous Subjective			
Frequency freeway mentioned spontaneously	82.612	24	.01
Make change with magic wish	21.834	6	.01
Major cause of dissatisfaction	34.088	6	.01
Reason for wanting to move	26.872	6	.01
Spontaneous Behavioral			
History of awakening from sleep	9.999	6	n.s.
Spontaneously mention activity interference:			
—Conversation	9.629	6	n.s.
—Television	6.657	6	n.s.
—Sleep	2.611	6	n.s.
—Relax	5.273	6	n.s.
—Read	7.758	6	n.s.
—All others	19.400	6	.01
Elicited Behavioral			
Rate annoyance with intereferences:			
—Television	22.270	6	.01
—Conversation	32.476	6	.01
—Sleep	21.863	6	.01
—Relax	14.819	6	.02
—Read	3.278	6	n.s.
—Other	14.822	12	n.s.
History of difficulty falling asleep	12.000	6	n.s.
Elicited Spontaneous			
Rating of annoyance with freeway noise	88.222	24	.01
Most annoying freeway feature	10.945	6	.09
Used to freeway noise	14.570	6	.02
Outdoor Behavioral			
Use of outdoor property	21.439	12	.04
Night closure of bedroom windows	7.943	12	n.s.
Closure of doors and windows	26.745	12	.01
Observance of closed doors and windows	7.489	8	n.s.

General Irritation			
Complaints about noisy neighbors	1.838	6	n.s.
Neighbors play television too loudly	2.900	6	n.s.
Annoyance with other features of neighborhood	94.703	42	.01
Annoyance with other noises in neighborhood	59.306	24	.01
Attitude to Freeways			
Awareness of freeway	48.461	12	.01
Importance of freeways	6.098	6	n.s.
Advantage of freeway proximity	18.013	6	.01
Highway officials' misfeasance	10.494	6	.10

Table D-2. Summary of X^2 Test of Association Between the Possible Responses for Each Item and the Two Sample Areas (Freeway and Nonfreeway).

	X^2	df	sign.*
Subjective Disturbance			
Desire to Move	1.03	1	n.s.
Has complained to Authorities about Neighborhood	9.74	1	.01
Would Like to Live in Remote Places	17.0	2	.01
Freeways are Inconvenient	5.79	3	n.s.
Behavioral Disturbance			
Difficulty Falling Asleep	3.39	1	.06
Is Awakened from Sleep	0.54	1	n.s.
Frequency Behaviors Mentioned Spontaneously	0.04	1	n.s.
Attitude to Freeways			
Importance of Freeways	0.58	1	n.s.
Advantage of Living Near	0.02	1	n.s.
Consideration of Freeway Planners	4.09	1	.04
Outdoor Behavior			
Use of Outdoor Property	0.39	1	n.s.
Closure of Bedroom Windows at Night	0.93	1	n.s.
Closure of Doors, Windows in Day	1.83	1	n.s.
Observance of Window Closure	2.82	1	.09

VARIABLE	SPONTANEOUS SUBJECTIVE Multiple R^2	R^2	R^2 Increase	Beta	SPONTANEOUS BEHAVIORAL Multiple R^2	R^2	R^2 Increase	Beta
L	.278	.077	.077	.218	.127	.016	.016	.084
50	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-
Fear of Accidents	.290	.084	.007	.027	.165	.027	.011	.095
Awareness of Noise	.319	.102	.018	.073	.166	.028	.001	.227
One Part Time	.326	.106	.004	-.070	.179	.032	.004	.106
[illegible] Full Time	.326	.106	.000	-.024	.179	.032	.000	.167
One Full Time	.336	.113	.007	-.064	.192	.037	.005	-.097
Income	.348	.121	.008	.101	.193	.037	.000	.043
Age	.348	.121	.000	-.000	.194	.037	.000	.036
Yrs. of Fwy. Exposure	.358	.128	.007	.045	.196	.038	.001	.089
Percent White	.378	.143	.015	.091	.205	.042	.004	.062
Percent Black	.388	.150	.007	-.081	.206	.042	.000	.027
Percent Spanish	.389	.151	[illegible]	.021	.207	.043	.000	-.039
Percent Facing Fwy.	.392	.153	.002	.041	.212	.045	.002	-.054
Sex	.393	.154	.001	.033	.213	.045	.000	-.014
Housing Status	.393	.154	.000	.005	.214	.046	.000	-.002
Comm. Interference	.398	.158	.004	.07[illegible]	.241	.062	.016	.139
Voluntary Residence	.401	.160	.002	-.049	.271	.075	.013	-.128
Acquaintance with Neig.	.414	.172	.012	.067	.311	.097	.021	.106
General Irritation	.416	.173	.001	.054	.317	.100	.003	.087
Malfeasance	.429	.184	.010	.091	.317	.101	.000	.234
Advantage living nr.	.446	.199	.015	.104	.337	.114	.013	.389
Fwy. Importance	.453	.205	.006	.085	.337	.114	.000	.213
Attitude	.453	.205	.000	.003	.361	.130	.016	-.641

VARIABLE	ELICITED SUBJECTIVE Multiple R^2	R^2	R^2 Increase	Beta	ELICITED BEHAVIORAL Multiple R^2	R^2	R^2 Increase	Beta	OUTDOOR BEHAVIOR Multiple R^2	R^2	R^2 Increase	Beta	
L	-	-	-	-	-	-	-	-	-	-	-	-	
50	.304	.092	.092	.228	.177	.031	.031	.074	.176	.031	.031	.162	Bedroom Faces
90	-	-	-	-	-	-	-	-	.334	.111	.080	.275	Fwy-last scale only)
Fear of Accidents	.364	.133	.040	.133	.342	.117	.085	.184	.350	.123	.011	.057	
Awareness of Noise	.404	.163	.030	.165	.373	.139	.022	.181	.351	.123	.001	-.022	
One Part Time	.414	.171	.008	.016	.379	.144	.005	.320	.354	.125	.002	-.223	
[illegible] Full Time	.414	.171	.000	.094	.379	.144	.000	.385	.354	.125	.000	-.169	
One Full Time	.425	.181	.010	-.068	.391	.153	.008	-.075	.354	.125	.000	.017	
Income	.425	.181	[illegible]	.031	.391	.153	.000	.012	.354	.125	.000	-.007	
Age	.426	.181	.000	.071	.397	.158	.004	.009	.364	.132	.007	-.092	
Yrs. of Fwy. Exposure	.427	.182	.001	.016	.398	.159	.001	-.007	.369	.136	.004	.067	
Percent White	.446	.199	.017	-.028	.399	.159	.000	-.010	.372	.138	.002	-.042	
Percent Black	.454	.206	.006	[illegible]	[illegible]	.165	.006	-.053	.372	.138	.000	.002	
Percent Spanish	.455	.211	[illegible]	-.129	.406	[illegible]	.002	.039	.372	.138	.000	.017	
Percent Facing Fwy.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.386	.149	.010	[illegible]	
Sex	.464	.215	[illegible]	.066	.413	[illegible]	.000	-.001	.386	.149	.000	-.025	
Housing Status	.454	[illegible]	[illegible]	.005	[illegible]	[illegible]	[illegible]	-.014	.390	.152	.003	-.059	
Comm. Interference	.464	.212	.000	-.017	[illegible]	[illegible]	.001	.029	.406	.167	.014	-.123	
Voluntary Residence	.476	.227	.012	-.103	[illegible]	[illegible]	.006	-.059	.411	.169	.002	-.050	
Acquaintance with Neig.	[illegible]	.306	[illegible]	.218	.523	.274	.098	[illegible]	.421	.177	.008	.020	
General Irritation	[illegible]	.308	.000	-.002	.524	.274	.000	.018	.427	.182	.005	.110	
Malfeasance	.556	.309	.000	.009	.525	.276	.002	[illegible]	.428	.183	.001	-.122	
Advantage living nr.	.569	.325	.016	.171	.541	.292	.016	.229	.428	.183	.000	[illegible]	
Fwy. Importance	.574	.329	.004	.115	.541	.292	.000	.059	.432	.187	.004	-.056	
Attitude	.575	.330	.001	-.135	.542	.294	.019	.221	.432	.187	.000	-.028	

Table D-3. Multiple Regression on Measures of Community Response.

APPENDIX E
SUMMARY OF WORKERS' QUALIFICATIONS

Interviewers

Ms. T. M.A. Clinical Psychology, 1972, University of Southern California. Doctoral candidate, 1974. Psychology intern, Los Angeles County General. Counselor, Student Counseling Center.

Mr. B. M.A. Psychology, 1972, University of Southern California. Doctoral candidate, Clinical Psychology, University of Southern California, 1974 Private practice psychotherapy. Human Factors Psychologist for 25 years.

Mr. J. Master's candidate, Psychology, 1973, Loyola University. Counselor, Community Free Clinics.

Ms. K. Candidate for B.A. Psychology, California State University at Los Angeles, 1974. Certificate in Paraprofessional Psychology, Los Angeles City College. Abortion Counselor. Personnel Counselor. Encounter Group Leader

Mr. M. Doctoral candidate, Clinical Psychology, University of Southern California, 1973 Upward Bound Counseling. Seminary work with street gangs in Chicago. Psychology intern, Child Guidance Clinic.

Mr. G. A.A., Psychology, Los Angeles City College, 1974 Psychology Department Outstanding Student Award. Primary therapist, University of Southern California, County Medical Center. Tutor in Psychology, Philosophy.

Ms. S. B.A. University of California, Berkeley, 1967. Candidate for M.S.W , University of Southern California, 1974 Interviewer, Los Angeles County Department of Public Social Services for 5 years.

Mr. D. Candidate for B.A., Psychology, California State University at Los Angeles, 1974. Parole Officer and Interviewer, Los Angeles County Department of Public Social Services for 4 years.

Ms. C. Master's degree, Counseling Psychology, 1970, University of Illinois. Interviewer, Sociology Survey Service, Illinois, for two years. Research and teaching in social science for 5 years.

Mr. S. B.A. Public Relations, 1974, University of Southern California. Navy Communications for 4 years; interviewing to NCVA for one year

Note: Two of the principal researchers also functioned as interviewers.

Field Operators

Dr. B. Ph.D. Physics, 1972, University of Southern California. Post-doctoral research, University of Southern California. Research and teaching in physics for 2 years.

Mr. A. M.S., Electrical Engineering, University of California, Berkeley, 1966 Doctoral candidate, Quantum Electronics, University of Southern California, 1974 Engineer, experimental physicist for 4 years

Mr. P. M.S. Aeronautics and Astronautics, 1967, Massachusetts Institute of Technology. Doctoral candidate, Aerospace Engineering, University of Southern California, 1974. Acoustical scientist for 6 years.

Mr. N. M.A. Physics, University of Southern California, 1972. Doctoral candidate, Physics, University of Southern California. Research with Pioneer Project at California Insitute of Technology.

Mr. Z. M.S Physics, 1967, Michigan State University Doctoral candidate, Materials Science, University of Southern California, 1974. Teaching and research at University of California, Los Angeles and University of Southern California for 8 years

Mr. Q. B.S. candidate, Civil Environmental Engineering, 1974 Field operator for private acoustical firm for 2 years.

Mr. T. M.A. Physics, University of Southern California, 1974. Doctoral candidate, Experimental Physics for 2 years.

APPENDIX F
STEP-BY-STEP MEASUREMENT PROCEDURE
(Instructions Given to the Field Operators)

Power Connection

1. First, *check* to see that the remote switch connected to the inverter is in the OFF position. If not, place the remote switch in the OFF position. Disconnect any equipment that might be connected to the inverter.
2. Lift the red plastic cover off the the battery container. Remove the wing nuts from the battery terminals. Place the slug labeled positive (+) in the + terminal of the battery and tighten the wing nut over it firmly. Place the slug labeled negative (-) in the - terminal of the battery and tighten the wing nut over it firmly. Replace the red plastic cover. Place the belt around the battery box and tighten.

Precautions

1. The battery is *not* spill-proof. Thus it must be kept in an *upright* position at all times.

   Keep the battery away from *sparks* and *fire*, to prevent explosion of the battery.
3. Handle one terminal of the battery at a time. Working with dry right hand is preferable.

Testing Set-Up

1. After you have connected the inverter to the battery, place the inverter in a stable location and in a well-ventilated area, especially if the inverter is to be used for a long time. Ventilation is essential to the inverter to prevent it from overheating. Car upholstery could be damaged by heat.
2. Place the B & K 4145 one-inch condenser microphone on the microphone extension cable and tighten gently. Place the tripod outside and close to the car and make sure of its stability. Place the microphone on the tripod and tighten the holding screw firmly. Connect the other end of the microphone cable to the 2209
3. Connect the ac output of the 2209 with the input of the 166, using the light gray cable.
4. After making sure that the inverter remote switch is in the OFF position, plug the powercord of the 166 into the outlet on the inverter
5. Now the set-up is ready for calibration and measurements

Calibration

1. Turn the 2209 meter switch to BATTERY position and assure that the 2209 batteries are still good. Wait until needle on meter settles before making a judgment. Replace batteries if they need replacement, being careful to place new batteries in the polarities shown on the inside of the battery compartment
2. Set the 2209 as follows:
   Weighting network switch: LIN
   Meter switch: FAST (this will turn on the 2209)
   Input amplifier attentuator knob: full way, clockwise.
   Output amplifier knob: 120
3. Set the 166 as follows:
   Input: MIC
   Meter: ON
   Filter: LIN
   Base level. 95 dB
   Overlay plate: 95 dB
4. Place the inverter remote switch in the ON position. A slight humming sound will be audible from the inverter. Turn the 166 on.
5. Place the pistonphone calibrator on the condenser microphone and make sure it is stable and in the OFF position.
6. Turn the pistonphone calibrator ON and adjust the gain adjustment of the 2209 using a screwdriver for *zero* reading on the 2209 meter scale.
7. Now adjust the K factor of the 166 using a screwdriver for *zero* reading on the 166 meter scale. Then turn filter switch to "A" position.
8. Turn OFF the piston calibrator and remove it gently from the microphone.
9. Turn the 166 OFF, the 2209 OFF, and the inverter remote switch OFF.

Measurements

1. Disconnect the microphone from the 2209. Remove the microphone from the tripod and place it in a safe, stable place.
2. Move the tripod to the indicated position of measurement. Make sure tripod is stable. Place the microphone on the tripod and tighten the holding screw firmly.
3. Connect the microphone cable to the 2209.
4. Turn the meter switch to FAST position and monitor the meter needle while changing the Output Amplifier Attenuator knob, until the needle average deflection is about the −10 dB reading on the 2209 meter.

5. Turn the remote switch of the inverter ON. Turn the 166 power ON, wait a few seconds, then quickly zero all counters. This starts your measurements.
6. Continue measuring for 15 minutes, *i.e.*, until 13th window reads 150, then turn 166 power switch OFF at that instant.
7. In case of persistent extraneous noise interference (such as lawnmowers, children, dogs, trucks on the street, motorcycles on the street, airplanes or helicopters), interrupt measurement temporarily by turning 166 power switch OFF until disturbance has subsided.
8. In case 12th window counts about one per minute or more, turn baseline to 100, zero the counters in order to start measurement again. If the first window counts about one per minute or more turn baseline to 90, and zero the counters in order to begin measurement again.
9. Turn 2209 power OFF, then the inverter switch, then record 166 data.

Precautions

1. To save batteries, turn 2209 OFF when not in use for extended periods of time.